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Soil Survey
of
Thayer County, Nebraska

By

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Bureau of Chemistry and Soils

In cooperation with the University of Nebraska
State Soil Survey Department of the Conservation and Survey Division

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By E. A. NIESCHMIDT, in Charge, R. H. LOVALD, and R. L. GEMMELL, Nebraska Soil Survey, and R. C. ROBERTS, U. S. Department of Agriculture

COUNTY SURVEYED

Thayer County is in southeastern Nebraska, bordering Kansas. (Fig. 1.) Hebron, the county seat, is in the central part of the county about 65 miles directly southwest of Lincoln, the State capital. The county is square, each boundary being about 24 miles long. It comprises an area of 575 square miles, or 368,000 acres.

Physiographically the county is part of an incompletely dissected constructional plain, most of which was once mantled to various depths by a deposit of light-gray silty material, known geologically as the Peorian loess. This deposit still covers most of the area included in Thayer County, but it has been removed in places, exposing the underlying formations. The light-gray loess is underlain by reddish slightly more sandy loesslike material known by Nebraska geologists as the Loveland phase of the loess. The next lower formation is gray or reddish-brown loose sand or a heterogeneous mixture of sand and gravel containing more or less glacial material. It is known as the sand sheet and overlies the bedrock of the region. Bedrock consists of alternating layers of bluish shale and gray or almost white limestone which rests on the lowest exposed formation in the county, pale reddish-brown loosely indurated sandstone.

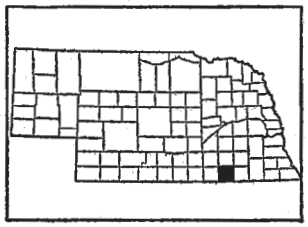

FIGURE 1.—Sketch map showing location of Thayer County, Nebraska

Throughout most of the northern half of the county the smooth gray loess mantle has been removed only along the major drainage ways, where the relief is rather pronounced. The greater part of the surface, however, ranges from nearly level to gently undulating, being characterized by slight swells and sags. Most of the sags include scattered basinlike depressions which range from a few acres to three-fourths square mile in size. Locally the surface is modified by shallow draws.

The plains in the southwest quarter and south-central part of the county, and those occupying the divide between Rose Creek and Little Blue River southwest and northeast of Gilead, are somewhat rougher than those in the northern half. In places they are modified by numerous steep-sided drainage ways with a general northeast-southwest trend, which are separated by narrow flat or more or less rounded divides. Elsewhere the slopes are gradual, and the divides

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are broad and flat topped, the surface in general being similar to that in the northern half of the county. Between these extremes are nearly all forms of relief, but the greater part of the surface is characterized by hills and valleys, modified to considerable extent by remnants of the original loess-covered plain which have escaped destructive erosion.

The surface relief ranges from gently undulating to extremely rough and broken, but is in general rolling or hilly. The more nearly level land occurs where flat-topped spurs of the original plain extend along the broader divides and the rougher areas where erosion has been deep enough to remove the old loess mantle and expose the underlying formations. Over most of the surface the major slopes are moderate and the ridges well rounded. Some soil slipping occurs and there are a few vertical steplike exposures on the steeper slopes, but these are not characteristic. The minor slopes are short, and most of them are rather steep.

The alluvial lands of Thayer County include the terraces and flood plains along Little Blue River, Rose Creek, and their larger tributaries. They lie from 80 to 120 feet below the general level of the uplands. The terraces and flood plains are most extensively developed in Little Blue River Valley which crosses the central part of the county in an east-west direction. They occur on both sides of the stream and have a combined width ranging from three-eighths mile to about 2½ miles. The width of the alluvial lands along Rose Creek averages much narrower, seldom exceeding one-half mile; along the smaller creeks and branches the width ranges from a few rods to about one-eighth mile. The surface of all the terraces is flat or gently undulating, except where roughened by wind or streams. The transition between the different terrace levels and between the terraces and the bottom lands is marked, in most places, by a short, steep slope, whereas the slope to the uplands is generally long and gradual.

The flood plains, or first bottoms, occupy the lowest positions in the county, occurring as strips of various widths along most of the larger streams and locally along the smaller drainage ways. The bottom lands are in general flat, though they are modified in places by old and present channels, cut-offs, slight elevations, and shallow depressions. They are subject to overflow in places during high stages of the streams, but the slope is usually sufficient down the valleys and toward the channels to remove the surplus moisture when the streams recede.

The elevation of Thayer County averages 1,540 feet above sea level and ranges from approximately 1,360 feet where Little Blue River crosses the eastern county line to about 1,700 feet in the southwest part near Byron. The average elevation of the loess plains is about 1,600 feet, and that of the bottom lands 1,470 feet above sea level.

Well water of excellent quality is readily obtained in all parts of the county except locally in the rougher uplands where bedrock interferes. The upland wells through the loess plains range from 80 to 120 feet in depth, in the loess hills the wells seldom exceed 80 feet, and in the alluvial lands an adequate water supply can be ob-

tained within a depth ranging from 10 to 60 feet, depending on the thickness of the deposits. Several artesian wells in the vicinity of Alexandria furnish an abundant and continuous supply of water.

Native timber, consisting chiefly of willow, boxelder, ash, elm, oak, and cottonwood, grows in narrow belts along all the larger and most of the smaller drainage ways. Walnut, hackberry, honeylocust, and basswood grow in some places. A few scattered cedar trees occur throughout the severely eroded upland sections south of Rose Creek, between Gilead and Alexandria, and many small groves have been planted in all parts of the county. Some of the trees attain merchantable size, and the timber is used for local construction. Most of it, however, has value only for posts or firewood.

The first permanent settlement in the area now known as Thayer County was made in 1856 in the Big Sandy Creek Valley near Alexandria. Within the next 20 years settlement spread throughout the area and by 1870 most of the land was homesteaded. The boundaries of the area now included in the county were established in 1872. The early settlers were descendants of many nationalities, especially German, but most of them were born in North America. According to the Federal census reports, the population of the county was 6,113 in 1880, 12,738 in 1890, 14,325 in 1900, 14,775 in 1910, and 13,976 in 1920. According to the 1920 report the population in that year averaged 24.2 persons to the square mile and was all classed as rural. It is rather evenly distributed but is slightly denser on the loess plains and in the valleys than throughout the loess hills and more severely eroded sections. More than two-thirds of the inhabitants are of native parentage, the rest are either of foreign birth or have at least one foreign-born parent.

Hebron, the largest town and county seat, had a population of 1,513 in 1920. It is an important market and distributing center for farm products and supplies. A number of small towns and villages are located on railroads and furnish local markets for the surrounding communities.

The transportation facilities of Thayer County are good. Several railroads, including main or branch lines of the Chicago, Burlington & Quincy, the St. Joseph & Grand Island, the Chicago, Rock Island & Pacific, and the Chicago & North Western systems traverse the county and furnish good connections with Lincoln, Omaha, St. Joseph, and Kansas City. No part of the county is more than 8½ miles from a railroad point.

The public-road system is well developed. Most of the roads follow section or land lines except in the rougher parts of the county where they conform to the topography on account of the lower construction and maintenance expense. State Highway No. 3 and Federal Highway No. 81 cross the county in east-west and north-south directions, respectively. These highways are surfaced with gravel. The other important roads, especially those between the towns, are kept in good repair. Sixteen bridges cross Little Blue River within the county, and cement or steel bridges and culverts are common even on the minor roads. Rural delivery routes and telephone lines reach all sections.

The county has a rural-school system of 101 districts, and the schoolhouses are well distributed. High schools are maintained in nearly all towns, and there is a college and academy at Hebron. Churches are numerous and conveniently located, especially in the southwestern part of the county.

Most of the surplus farm products are sold in the towns for shipment to outside markets. Flour mills at Alexandria, Bruning, Deshler, and Hebron afford local markets for much of the wheat. The Hebron mill serves as a power plant. Most of the surplus grain is handled in local elevators for shipment to larger markets. Dairy products are marketed chiefly in Lincoln and Beatrice, and a creamery at Deshler uses a part of the surplus cream. Livestock, mainly cattle and hogs, is shipped to Kansas City, St. Joseph, and Omaha.

CLIMATE

The climate of Thayer County, in general, is favorable for grain farming and livestock raising, though it is marked by wide seasonal variations. The winter is moderately long and cold, the summer warm, the spring rather cool with considerable precipitation, and the fall moderate in temperature with only occasional periods of rainy weather.

The average date of the last killing frost is April 28 and that of the first is October 6. This gives an average frost-free season of 161 days, which is ample for the maturing of all the commonly grown farm crops. Killing frost has been recorded as late as May 27 and as early as September 12. Fruit is sometimes injured by late spring frosts, especially when the frost follows unusually warm periods during which the fruit buds have developed.

About 44 per cent of the mean annual precipitation of 27.62 inches falls during the principal part of the growing season, June, July, and August. The driest months are November, December, January, and February, each with less than 1 inch of normal precipitation. Most of the summer rainfall occurs during local thunderstorms. The rainfall in May and June is usually well distributed, but in July the distribution is less favorable, though hardly a week passes without some rain. In August and September the precipitation is lighter, and frequently short droughts occur which sometimes reduce grain yields. Total crop failures, however, are practically unknown, as most of the soils are retentive of moisture. The annual snowfall varies from a few inches to several feet, averaging 21.4 inches.

In winter the prevailing winds are from the northwest and in summer chiefly from the south and southeast. Strong winds are common, but tornadoes are rare.

Table 1, compiled from records of the United States Weather Bureau station at Hebron, is representative of climatic conditions throughout the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Hebron, Nebr.*

[Elevation, 1,458 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1894)	Total amount for the wettest year (1902)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	28.6	69	−22	0.73	0.54	1.17	4.4
January	24.4	71	−25	.62	.19	1.27	3.7
February	27.2	80	−34	.86	.78	.33	5.5
Winter	26.7	80	−34	2.21	1.51	2.77	13.6
March	38.9	91	−13	1.29	.97	.71	4.6
April	52.4	100	11	2.53	1.46	.65	1.3
May	61.5	101	23	4.28	1.59	4.19	.2
Spring	50.9	101	−13	8.10	4.02	5.55	6.1
June	71.6	105	39	4.59	6.51	7.70	.0
July	76.5	109	47	3.79	1.75	13.30	.0
August	74.9	107	41	3.32	.15	7.35	.0
Summer	74.3	109	39	11.70	8.41	28.35	.0
September	67.0	103	25	2.78	1.74	4.70	.0
October	54.0	93	13	1.92	1.01	3.32	.3
November	39.9	80	−11	.91	[1]	1.32	1.4
Fall	53.6	103	−11	5.61	2.75	9.34	1.7
Year	51.4	109	−34	27.62	16.69	46.01	21.4

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The first white people to realize the agricultural possibilities of the area now included in Thayer County were emigrants en route to the gold fields of California in the early fifties. In 1856 the first permanent settlers established themselves along the Oregon Trail which followed the Big Sandy Creek Valley in the eastern part of the county and the divide between Big Sandy Creek and Little Blue River in the western part. The first crop was sod corn, grown for home consumption and for sale to the emigrants. The yields were considered satisfactory, and the farming possibilities of the region became known. As conditions became more stable, spring wheat, oats, buckwheat, rye, barley, and garden vegetables were also grown. For meat supplies the pioneers depended on wild game and beef.

The early agricultural development of the county was slow because the settlers were not familiar with the local climatic and soil requirements. The seed used, which was brought largely from States farther east, was not well suited to the comparatively low rainfall in Thayer County. Little attention was given to the preparation of the seed bed, and consequently yields were rather low. In 1874, 1875, and 1876 the crops were practically destroyed by grasshoppers, and in the early nineties droughts were unusually severe. Many farmers became so impoverished that they were forced to leave the county.

The recent tendency is to improve the crops by using carefully selected native seed, to conserve soil moisture by intensive cultivation, and to maintain or increase the productiveness of the land by manuring, crop rotation, and the growing of leguminous crops, such as alfalfa and sweetclover.

The Nebraska agricultural statistics[1] report 237,474 acres, or almost two-thirds of the county, under cultivation in 1926. The same report shows that 106,969 acres are in pasture land and 10,946 acres in woodland.

The present agriculture of Thayer County consists of diversified farming, including the growing of grain and hay, and the raising of livestock.

According to the Federal census the principal crops in 1919 were corn, wheat, oats, alfalfa, wild hay, coarse forage, barley, and rye, ranking in acreage in the order named. During the same year the value of all cereals was $4,867,414, and all other crops were valued at $1,121,877. The total value of all domestic animals was $3,247,980, of dairy products, exclusive of those used on the farm, $420,501, and of poultry and eggs, $448,292. The average value of farm land was $111.32 an acre.

In 1919 inflation in prices caused by the World War, caused an increase in acreage devoted to several of the crops. Conditions have since become more nearly normal and the acreage, especially of wheat and barley, has decreased and that of corn has increased. In 1926 corn was planted on 121,868 acres, followed by wheat, oats, alfalfa, wild hay, and coarse forage in decreasing acreages, respectively. The average price of farmland during that year was $101 an acre.

The total corn yield in 1926 was 365,604 bushels, and it was valued at $248,611. Owing to an unusually prolonged and severe drought and hot winds during July and August, the average acre yield was only 3 bushels, the lowest ever recorded. The average yield over a period of 10 years is 21.4 bushels to the acre.

Corn is grown in all parts of the county except in the more poorly drained parts of the uplands and bottom lands and in the more gravelly or stony sections. The acreage devoted to corn steadily increased until about 1899, then decreased until 1919, and is now again increasing. In 1926 there were 59 silos in the county, and on farms equipped with silos from 10 to 20 acres of corn are cut each year for silage. All the corn is of the dent varieties. Reid Yellow Dent, Iowa Silvermine, Leaming Improved, Nebraska White Prize, and hybrids of these varieties are most commonly grown.

Wheat is the principal small-grain crop. In 1879 the acreage in wheat was larger than that in corn and oats combined. About 1885, however, the wheat acreage was greatly reduced on account of low prices and low yields, and in 1889 only 6,436 acres were in wheat. It was not until Odessa, a variety also called "Grass" wheat, which yielded exceptionally well when planted in the fall, was introduced, that winter wheat regained the lost territory. During the World War and the postwar period, market conditions were very favorable and the wheat acreage was greatly extended. Since the deflation of

[1] All data subsequent to those obtained from the 1920 Federal census are from the Nebraska agricultural statistics.

prices the acreage has been reduced, and the present acreage devoted to wheat is approximately one-half as large as that used for corn.

The Nebraska Department of Agriculture reports wheat on 61,171 acres in 1926 with a total yield of 856,314 bushels, or an average of about 14 bushels to the acre, which is about the average for the last 10-year period. The total value of the crop was $1,001,877.

Winter wheat is grown almost exclusively. It can be planted in the fall after the busy season is over. It matures earlier than spring-planted wheat and is therefore less affected by dry weather and hot winds. The yields fluctuate less than those of spring wheat, and there is less danger from smut and rust. The leading varieties grown are Turkey and Kanred.

Oats rank next to wheat in acreage. In 1926 there were 25,988 acres in oats with a total yield of 285,978 bushels, or an average of 11 bushels to the acre. The crop was valued at $114,391. The yield that year was exceedingly low, on account of unfavorable weather conditions during the growing season. The average annual yield for the 10-year period preceding this was 29.1 bushels.

The acreage of oats has slowly decreased since the beginning of the twentieth century owing mainly to the larger returns from corn and wheat. The leading variety of oats is Kherson, which is especially suited to bottom soils on account of its short stiff stem, which reduces the danger of lodging.

Among the grain crops rye ranks next in acreage. The area devoted to this grain varies considerably, depending on the market. In 1926, 702 acres were in rye with an average yield of 8 bushels to the acre. Barley is the least important grain crop in Thayer County. It had practically been abandoned by 1914 but the acreage increased remarkably during the war and postwar years. The Federal census reports 2,901 acres devoted to this crop in 1919 with an average yield of 21.4 bushels to the acre, and in 1926 only 78 acres were in barley.

Hay production has been important since the early settlement of the county. The acreage of wild hay, however, has gradually decreased with the increase in grain crops and tame hay. At present alfalfa is the most important tame-hay crop. In 1926 it occupied 14,607 acres with an average yield of 1.7 tons to the acre. The total crop was valued at $368,507. The varieties of alfalfa grown are among the most hardy, including Common, Grimm, and Cossack, all of which are extremely resistant to winter killing. The remaining tame-hay crops include Sudan grass, sweetclover, timothy, and millet.

In 1926 wild hay was cut from 9,731 acres and yielded 4,866 tons. The principal wild-hay grasses are big bluestem, little bluestem, grama grass, buffalo grass, bluegrass, and bunch grass in well-drained situations and marsh grasses where moisture is excessive. These grasses will support from 30 to 40 head of cattle to the quarter section during the summer grazing season, from June to October. When cut for hay they yield from one-half to 1½ tons to the acre, depending on moisture conditions.

Sorghum was planted on 4,402 acres in 1926 and yielded an average of 1.6 tons to the acre. Among the minor crops, potatoes, kafir, and spelt are the most important. They are grown in small patches for feed and home consumption.

Fruit production does not receive much attention and there are no commercial orchards in the county, although on most farms there are a few apple, peach, and cherry trees. Some grapes are grown.

Livestock raising is an important agricultural industry. In 1926, the total value of crops, excluding a few minor ones, was $1,918,972, and that of livestock was $2,661,880.

Among the animals, cattle are the most valuable, though they are outnumbered by hogs. In 1926 the 27,217 cattle in Thayer County had a total value of $1,103,129. Of these 9,019 were listed as milk cows. There are a few purebred Holstein herds near the larger towns. The value of dairy products, excluding those used for home consumption, was $661,868 in 1926. In the same year there were 44,147 hogs valued at $759,328 and 10,109 horses valued at $613,111.

Farm improvements in Thayer County are generally good, and with few exceptions all farms are equipped with modern labor-saving machinery. Most of the fences are of barbed wire, although considerable woven-wire fencing is used around feed lots, gardens, and alfalfa fields. Most of the buildings are painted and kept in good repair. Four-horse teams of medium or heavy draft horses and mules are commonly used for the farm work. In recent years the number of tractors has increased rapidly, and in 1926 they replaced horses during busy seasons on about 16 per cent of the farms. According to the Nebraska agricultural statistics there were 272 gas tractors, 681 gas engines, 109 trucks, and 1,760 automobiles on the farms in 1926. In the same year 1,280 cream separators, 571 incubators, and 200 grain threshers were in use. Numerous farmhouses are equipped with modern heat, light, and water systems.

Farm labor is plentiful except during harvest seasons as most of the work is done by the farmer and his family. Wages range from $35 to $45 a month with board and room. Day laborers receive from $2.50 to $3.

The farms in Thayer County have increased greatly in number and acreage since 1880. In 1926, 98.4 per cent of the county was in farms and 93 per cent of the farm land was improved.[2] The average value of all farm property to the farm, including land, buildings, machinery, and domestic animals, as reported by the Federal census was $2,213 in 1879, $4,640 in 1889, $5,670 in 1899, $16,783 in 1909, and $26,390 in 1919. According to the Nebraska agricultural statistics it was $23,875 in 1926.

In the last 45 years the proportion of the farms operated by owners has greatly decreased. In 1880, 73.9 per cent of the farms in the county were operated by owners, and in 1926 only 26.8 per cent of them were so operated. Owners were on 465 farms, tenants on 951, and part owners on 316 farms during the latter year.

The share-rental system predominates in Thayer County, 79 per cent of the rented land being rented for a share of the crops in 1926. In the better-farming sections of the county the owner's share is two-fifths of the corn and one-third of the small grain delivered in the town or to the nearest elevator by the tenant, who also receives

[2] Improved land as defined by the United States census includes all land regularly tilled or mowed, land and pasture which has been cleared or tilled, land lying fallow, land in gardens, orchards, vineyards, and nurseries, and land occupied by farm buildings. The classification is not always easy to make and these statistics therefore must be considered at best, only a close approximation.

one-half of the alfalfa hay left in the stack. The tenant furnishes all machinery, labor, and seed. In the rougher sections or where the land is less productive, the owner receives only one-third of the grain crops for the use of the land. The better pasture land rents for $3 an acre.

The current selling price of farm land ranges from $25 to $200 an acre, depending on the character of the soil, topography, drainage, improvements, and location with respect to markets. The average price is about $100 an acre. The best upland farms bring from $150 to $185 an acre, whereas those located in the rougher sections along Rose Creek and Little Blue River are valued at $50 or $60. The more sandy parts of the eroded uplands bring from $30 to $50. The highest-priced land occupies the terraces and the better-drained bottom lands, and is seldom sold for less than $200 an acre.

AGRICULTURAL INDUSTRIES

In Thayer County much attention is given to the fattening of cattle and hogs. Dairying and poultry raising are minor industries. Fruit and vegetables are grown only in sufficient quantities to supply farm needs.

Corn is the leading crop and most of it is fed on the farms where produced to hogs, cattle, and work animals. On tenant farms, however, considerable corn is sold, either to local feeders or in outside markets.

Wheat is the chief cash crop and there are elevators for storing the grain in nearly every town. The wheat is usually hauled directly from the threshing machine to the elevators, where it is sold and shipped to outside points. Flour mills are located in Hebron, Alexandria, Deshler, and Bruning, and many farmers sell their wheat in these mills.

Some of the cattle to be fattened are raised locally but the greater part are purchased in the markets at Omaha or Kansas City or from ranchers in more western counties. The cattle are fed corn and alfalfa from 60 to 90 days and then marketed. Most of them are Herefords or Shorthorns.

Practically all the hogs are raised locally, most farmers keeping from 20 to 60 head. Many hogs are raised in connection with the feeding of beef cattle. There are many purebred herds in the county and all the animals are of good breeding. Duroc-Jersey, a big type of Poland China, and Hampshire are the leading breeds.

Dairying is gradually being extended in connection with general grain farming. There are comparatively few purebred dairy cattle but enough are kept to serve as a basis for developing the dairy industry. The abundance of alfalfa to balance the corn ration and good marketing facilities combine to favor the extension of the dairy industry. Most farmers milk from 6 to 10 cows, chiefly of the beef breeds. The surplus dairy products are sold in local cream stations from which they are shipped to creameries in Deshler, Fairmont, and Lincoln. Most of the purebred dairy cattle are Holsteins.

Poultry is a valuable asset on most farms, although no farm is devoted exclusively to the poultry industry. The local demand for poultry products is good, and poultry is receiving increased attention.

The principal breeds of chickens are Plymouth Rock, Leghorn, and Rhode Island Red.

SOILS AND CROPS

The greater part of Thayer County, approximately 80 per cent, is topographically suited to cultivation. The county has no important manufacturing or mining resources, and agriculture is the chief industry. More than 60 per cent of the inhabitants are on farms; the remainder are in small towns and villages and are supported largely by revenue derived from handling farm supplies and products.

The leading crops of the county are corn, wheat, oats, alfalfa, and prairie hay, ranking in acreage in the order named. The minor crops are sweetclover, rye, barley, millet, sorghum, garden vegetables, and fruits.

The leading natural factors affecting crop production in Thayer County, with the exception of climatic conditions, which are uniform, are surface features and soils. The climate has been described in a previous section of this report.

The soils of Thayer County occupy two major topographic positions, namely, uplands and alluvial lands. The upland soils are the more extensive, occupying about 85 per cent of the county. The soils in each position differ more or less from one another and from those in the other topographic position in character, in productivity, and in adaptability to farm crops. The differences have not caused specialized farming in any part of the county because the intimate and intricate association of the different soils on most farms has made it necessary to grow the leading crops more or less extensively on all cultivable soils.

The net profit derived from growing any given crop in Thayer County, assuming that the producer of that crop is an efficient farmer, depends largely on the weather, market conditions, and the adaptability of the crop to the soil on which it is grown.

Weather and market conditions, although extremely important, are variable and beyond the control of the farmer, but the adaptability of the crop to the soil may be controlled by him. He can, and does, grow corn more extensively than wheat on those soils which in average years are known to give greater returns when used for corn. Likewise, he grows wheat, alfalfa, or some other crop more extensively on soils for which they are best suited.

The upland soils of the county are used chiefly for grain crops, approximately 90 per cent of the cultivable acreage being used for corn, wheat, and oats. Alfalfa is also grown but the area devoted to this crop throughout the uplands is annually becoming smaller and that of sweetclover, larger.

Alfalfa does well during the first few seasons after planting but, as on nearly all upland soils in Nebraska, the yields decline after five or six years on account of insufficient moisture. The alfalfa plant has an exceptionally large root system, and extracts soil moisture from a considerable depth. A recent publication[3] by agronomists at the Nebraska Agricultural Experiment Station shows that alfalfa, on soil receiving moisture from precipitation alone in eastern Nebraska, as do all the upland soils of Thayer County except

[3] KIESSELBACH, T. A., RUSSEL, J. C., and ANDERSON, A. THE SIGNIFICANCE OF SUBSOIL MOISTURE IN ALFALFA PRODUCTION. Jour. Amer. Soc. Agron. 21: 241–268, illus. 1929.

those in the depressions, can deplete the stored soil moisture to depths beyond the reach of ordinary cereal crops within two years, and within five or six years can almost completely exhaust the available moisture in the substratum to a depth exceeding 25 feet. The publication indicates that alfalfa in Nebraska must depend almost entirely on annual precipitation for its growth after the first five or six years except in situations where the precipitation is supplemented by a moisture supply from other sources. Throughout the uplands, therefore, reduced yields may be expected from a second cropping to alfalfa.

The removal of deep-seated moisture does not materially affect grain crops following alfalfa, as they usually find sufficient water near the surface.

According to data obtained by Nebraska agronomists, it would seem that sweetclover should be more profitable in rotations on upland soils than alfalfa, as sweetclover [4] requires less moisture than alfalfa and is suited to shorter rotations. Moreover, it equals alfalfa in its ability to increase the available nitrogen content of the soil. It is being grown more extensively each year.

The total area devoted to corn on the upland soils considerably exceeds that in wheat and is probably greater than that in wheat and oats combined. Corn, however, is not the most extensively grown crop in all parts of the uplands. It is slightly exceeded in acreage by wheat throughout that part in which the soils have a heavy claypanlike layer in the upper part of the subsoil. Here oats and wheat are grown more extensively than on any other soil area of equal size in the county. Oats, however, occupy a comparatively small acreage. Rye, alfalfa, and sweetclover are also grown but are of minor importance. The approximate percentage of the claypan soils in wheat, corn, and oats, excluding those parts used for minor crops and farm sites, is 50, 40, and 10, respectively.

The cause of the larger wheat than corn acreage on those upland soils having claypanlike upper subsoil layers is that moisture conditions are more favorable for the production of wheat than of corn. The dense clay layer in the upper part of the subsoil limits the moisture available for crop roots chiefly to the topsoil. Shallow-rooted crops, therefore, such as wheat and oats which mature before the moisture supply stored in the topsoil during the winter months is exhausted, are naturally well suited to the claypanlike soils.

Corn, having a larger and deeper root system, maturing later than small grain, and requiring, therefore, a much longer period of growth, requires larger total amounts of moisture. It does well on the claypan soils, providing considerable precipitation occurs during the growing season, but usually suffers more or less from drought in average years.

The remainder of the upland soils have no claypanlike layer, moisture available for crop roots occurs throughout the subsoil, and conditions are more favorable for corn production than on the claypan soils. They are also more favorable for wheat production, especially in dry summers following unusually dry winters, when the available moisture in the claypan soils is insufficient to produce good yields of small grain. Corn, however, gives larger acre yields

[4] STEWART, P. H., and GROSS, D. L. SWEETCLOVER IN NEBRASKA. Nebr. Agr. Col. Ext. Circ. 122, 15 p., illus. 1923.

in average years than wheat and consequently is planted on about twice the acreage devoted to wheat. Oats, rye, and legume-hay crops are of minor importance, being used only as steps in the rotation between corn and wheat.

In the following pages the individual soils of the county are described, their relation to one another is shown, and their influence on the agricultural development and farming practices of the county is discussed. The location and area occupied by each of the soils recognized in the county are shown on the soil map accompanying this report. Their acreage and proportionate extent are given in Table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in Thayer County, Nebr.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Crete silt loam	133,760	36.3	Waukesha very fine sandy loam	5,440	1.5
Hastings silt loam	92,160	28.1	Hall very fine sandy loam	5,184	1.4
Eroded phase	11,392		Judson very fine sandy loam	2,112	.6
Thayer silt loam	4,224	1.1	Judson fine sandy loam	1,152	.3
Pawnee silt loam	576	.2	Wabash silt loam	5,824	1.6
Nuckolls silt loam	21,312	7.1	Wabash very fine sandy loam	832	.2
Light-colored subsoil phase	4,736		Lamoure silt loam	3,264	.9
Nuckolls loam	12,416	3.4	O'Neill very fine sandy loam	4,224	1.1
Lancaster fine sandy loam	128	.1	O'Neill sandy loam	1,280	.4
Sogn silt loam	3,456	.9	O'Neill sand, light-colored phase	192	.1
Shelby fine sandy loam	8,768	2.4	Cass fine sandy loam	9,344	2.5
Shelby very fine sandy loam	5,952	1.6	Cass silt loam	832	.2
Shelby gravelly loamy sand	3,008	.8	Sarpy sand	384	.1
Butler silt loam	9,856	2.7			
Scott silt loam	1,408	.4			
Waukesha silt loam	14,784	4.0	Total	368,000	

On the basis of drainage, which seems to be the most important factor in the economic utilization of the upland soils, these soils are divided into three broad groups; namely, well-drained, poorly drained, and excessively drained soils.

SOILS OF THE SMOOTH UPLANDS

The soils of the smooth uplands are well drained and are the most productive soils of the uplands, occupying 61.3 per cent of the area of the county. Crete silt loam and Hastings silt loam are the two types of this smooth upland group. These soils have developed on the uneroded or only slightly modified old loess-mantled plain which once covered the entire region, and practically all the land occupied by them is under cultivation. Their surfaces are nearly level or gently undulating, and topsoil characteristics which are most beneficial to crops are developed. However, in places the subsoils are not favorable to all crops.

The climate for ages past has favored a luxuriant growth of prairie grasses. Absence of serious surface erosion has allowed deep soil weathering and the topsoils are from 18 to 20 inches thick. They are also very dark, in many places almost black, owing to large accumulations of organic matter derived from the annual decay of grass roots. Moreover, the topsoils are decidedly granular or crumblike in structure.

The high organic-matter content and granular structure of the topsoils are beneficial in keeping the soil mellow and assisting in maintaining a favorable tilth. The dark color of the organic matter increases the power of the soil to absorb the sun's heat and thereby maintain a slightly higher temperature. The content of organic matter greatly increases the water-holding capacity of the soil material, insuring considerable protection against crop failure during droughts. It materially increases the stability of the substances that render a soil productive. In addition to these beneficial effects, organic matter is the chief source of nitrogen, which is one of the important plant foods.

The granular or crumblike structure so well developed in the topsoils facilitates easy penetration and therefore the maximum feeding range for crop roots. It allows free passage of air through the soil which is of advantage to growing crops. It facilitates cultivation under a wider range of moisture conditions than would be possible were the structure particles extremely fine.

Crete silt loam.—Crete silt loam has the dark-colored granular surface soil characteristic of this group. The distinguishing feature of this soil is a heavy brown claypan layer from 14 to 18 inches thick which lies directly beneath the topsoil. This layer restricts root development and both upward and downward movement of soil moisture. It practically limits the moisture available for growing crops to the amount that can be stored in the topsoil. Beneath the heavy claypan is almost white floury silt. This material is very limy, but the lime is of little value to plants as it is cut off by the claypan.

Nearly all the Crete silt loam is under cultivation. A few hundred acres north of Hubbell are devoted to the production of wild hay. Most of the soil is used for wheat, corn, oats, and alfalfa, ranking in acreage in the order named. Small patches of vegetables and forage crops are also grown on most farms for home consumption or for feed. The acreage in wheat is considerably larger than that in corn, and the area devoted to either wheat or corn is greater than that of oats, alfalfa, and forage crops combined.

Crete silt lom is not so well suited to corn as Hastings silt loam, because the crop requires a more prolonged and abundant moisture supply than is usually available in the topsoil, especially in dry years. Moreover, in common with all upland soils, the land is poorly suited for continued alfalfa production for reasons previously given. It is, however, well suited to wheat. Thayer County ranks high among the wheat-producing counties of Nebraska.

Crop yields on Crete silt loam depend largely on the rainfall and the care used in handling the soil. The average yield of wheat over a period of years is about 18 bushels to the acre, ranging from less than 8 to more than 30 bushels in seasons of exceptionally low and high precipitation, respectively. Corn and oats yield from 20 to 40 bushels, alfalfa from 1 to 2½ tons, and wild hay from one-half to 1 ton. The lowest yields of all crops usually follow an exceptionally dry winter.

Hastings silt loam.—Hastings silt loam has a mellow finely granular dark-colored surface soil very similar in appearance to the surface soil of Crete silt loam. The upper part of the subsoil, although brown like that of Crete silt loam, is comparatively friable allowing

easy root penetration and water percolation. Moisture available for growing crops is not limited to the topsoil, but occurs throughout the entire soil. The lower subsoil layer is limy and is similar to the corresponding layer in Crete silt loam. From the foregoing descriptions it is evident that Hastings silt loam is better suited to the production of a diversity of crops than Crete silt loam.

Hastings silt loam, although less extensive than Crete silt loam, ranks next to that soil, both in total area and agricultural importance. It occurs in various sized bodies on the more gradual slopes and on the narrower though flat-topped divides between drainage ways, most of the broader divides being occupied by Crete silt loam. Drainage is thorough, but seldom excessive, and practically none of the soil is subject to destructive erosion. About 85 per cent of the land is under cultivation, and the remainder is included in small farm pastures and building sites.

The absence of a claypan layer in the upper part of the subsoil gives this soil a decided advantage over Crete silt loam, especially for corn production, because the moisture available for crop roots is not limited to the topsoil, as in the Crete soil, but occurs throughout the subsoil, and in periods of prolonged drought, which sometimes occur in the summer, it is largely the subsoil moisture which enables the corn crop to properly mature.

Corn is the leading crop, followed by wheat, oats, and alfalfa, ranking in acreage in the order named. Crop yields are slightly higher than on Crete silt loam, but are a little more variable, particularly those of corn, than on the best upland soils of more eastern States, owing largely to a slightly greater annual variation in the summer rainfall. Corn yields from 25 to 60 bushels to the acre, with an average yield of about 35 bushels. Wheat averages about 18 bushels, and the oat yield is about the same as that of corn. The yield of alfalfa hay averages about 2½ tons to the acre during the first five or six years. Subsequent yields of this crop, however, seldom exceed 2 tons and average about 1½ tons.

SOILS OF THE ROLLING UPLANDS

The excessively drained group of soils of the rolling uplands occupies about 20.7 per cent of the county, ranking next in total area to the well-drained soils of the smooth uplands. This group includes soils of the Thayer, Pawnee, Nuckolls, Lancaster, Sogn, and Shelby series, and an eroded phase of Hastings silt loam. The individual members of the group, with few exceptions, occupy comparatively small areas. The soils as a whole are below the general level of the well-drained upland soils, occupying the valley slopes and more eroded parts of the county. They occur in strips of various widths on the valley sides of all the larger and many of the smaller drainage ways, but are chiefly in the eastern half of the county where the drainage is most intricate and deeply intrenched. The strips along Little Blue River, Sandy Creek, Rose Creek, Big Sandy Creek, and South Fork Big Sandy Creek are the widest, many of them extending a mile or more on each side of the alluvial lands, especially in those localities where tributary branches to the main streams are numerous and close together. Along the smaller streams and branches, extending back into the well-drained soil group of the

more nearly level and higher-lying uplands, strips of excessively drained soils are comparatively narrow.

The soils of this group, as a whole, have been subjected to considerable erosion. Conditions in most places have been less favorable for the accumulation of such large amounts of organic matter as in the Hastings and Crete soils, and the topsoils average thinner than in those soils. They usually extend to a slight depth, either resting on thin though generally friable subsoils or on slightly weathered parent material. In some places the topsoils have been entirely removed, exposing the subsoils, and in places where erosion has been especially severe the geologic formation is exposed. The complete removal of the topsoil, however, is rather local, and in most places this layer, although thinner and less granular than the corresponding layer in soils of the well-drained upland soil group, is present and remains dark even under cultivation. In places, especially on the more gradual slopes where erosion has been least active, it may be thick and similar in all characteristics to the topsoils in the well-drained group. In such localities the subsoil also is usually well developed.

The variations in this soil group caused by differences in the amount of erosion are too patchy and numerous to indicate on a small-scale map. The soils belonging to the group, therefore, have been mapped to include areas in which the topsoils are thick and well developed in some places and extremely thin or absent in others. In some places the separation between soils belonging to this group and those belonging to the well-drained upland group are not based on differences in erosion but on differences in the character of the soil material. Excessive drainage in most places has curtailed the development of those soil features most beneficial to crops, and the soils are naturally a little less productive than soils of the well-drained upland group.

Approximately 70 per cent of the land occupied by soils of the excessively drained upland group is under cultivation. Most of the remainder, including the more severely eroded parts, is in pasture. The approximate acreage of corn, wheat, and oats on the cultivable areas of this group is 50, 30, and 10 per cent of the total area, respectively. The remaining 10 per cent is used chiefly for minor crops, including sweetclover, alfalfa, and rye, and for farm sites.

Although corn is the most extensively grown crop, the proportional acreage devoted to corn and wheat in any particular locality depends on the character of the soil and the extent of erosion. On the more gradual slopes, where erosion is comparatively slight and the topsoils are comparatively thick, dark, and underlain by subsoils with high moisture-storing capacity, practically all crops common to the county do well. Corn, however, being the most profitable crop, is grown on 70 or 80 per cent of the total area occupied by such slopes. On the steeper slopes the topsoils are thinner and naturally contain less organic matter. The subsoils also, although friable, are usually thin, and the soils as a whole have a comparatively low moisture-storing capacity. Moreover, they actually absorb less moisture from rains than the soils on the more gradual slopes, because of the more rapid surface run-off. Small-grain crops having comparatively low moisture requirement are naturally bet-

ter suited to the steeper slopes than corn, and wheat is grown on probably 70 per cent of the area occupied by such slopes.

Hastings silt loam, eroded phase.—Hastings silt loam, eroded phase, occupies the steeper parts of the loessial uplands, occurring chiefly as small isolated bodies and narrow discontinuous strips on eroded valley slopes. It also occupies sharp divides between drainage ways. The topsoil, in most places, is very thin or entirely removed. On the steeper slopes both topsoil and subsoil are absent and the white limy silt from which all Hastings soils have weathered is exposed. In a few places, especially on the lower valley slopes, soil of this phase contains noticeable amounts of very fine sand throughout. In most places, however, it differs from typical Hastings silt loam only in those characteristics which are the direct result of erosion.

On account of its small extent and generally unfavorable topography, the soil is of little agricultural importance in Thayer County. Most of it is used for pasture land. The native vegetation consists of a good growth of grama, buffalo, bluestem, and other desirable pasture grasses, and will support from 40 to 50 head of cattle on each quarter section (160 acres) during the summer grazing season. Some hay is cut, and a few small areas on the more gradual slopes are under cultivation. All crops suited to Hastings silt loam will grow on the cultivated areas. The thinning of the topsoil, however, has been accompanied by a proportional decrease in organic matter and nitrogen and in the moisture-retaining power of the soil, resulting in lower yields of all crops than are obtained on Hastings silt loam except sweetclover and the first cropping to alfalfa. Alfalfa and sweetclover yields equal those on the typical soil because these crops are able to obtain most of their nitrogen from the air, and their massive root systems can obtain moisture and plant food from greater depths and larger areas than those of most cereal crops.

Thayer silt loam.—Thayer silt loam is similar to Crete silt loam in its major characteristics. The two soils are essentially alike in their crop adaptabilities and in comparable topographic positions produce equally high yields, especially of small grain. However, Thayer silt loam, in most places, has a less even relief than Crete silt loam and as a whole is more subject to erosion and consequently is a little less productive.

Areas of this soil occur chiefly south of Rose Creek in the southeastern part of the county. The total area is 6.6 square miles. Most of the soil occupies gradual or steep slopes and narrow or broad divides below the general upland level. Most of the divides, although prevailingly flat topped, are a little more dissected than those on which the Crete soil is developed.

The topsoil and upper subsoil layers are identical with those in Crete silt loam except that both are somewhat thinner, the topsoil being only about 12 inches thick, and the upper subsoil layer or claypan seldom exceeding 10 inches in thickness. The depth to the lower subsoil layer, therefore, is only about 22 inches in contrast to 36 inches in the Crete soil. The lower subsoil layer differs from the corresponding layer in Crete silt loam in being moderately compact dark grayish-brown silty clay with a faint reddish tinge. It is not quite so limy as the corresponding layer in the Crete soil.

The lower subsoil layer rests on disintegrated limestone at a depth of about 32 inches beneath the surface of the ground, and the entire soil has apparently weathered from this limestone formation. On some of the steeper slopes erosion has removed all the soil material, in places exposing the limy bedrock. Such areas, where sufficiently extensive to warrant mapping, are included with Sogn silt loam, but where local and patchy they are indicated on the soil map by rock-outcrop symbols.

On account of its small extent, the soil is of minor importance in the general agriculture of Thayer County. Only about 50 per cent of the land, including the more nearly level areas, is under cultivation. About 80 per cent of the cultivated area is used for wheat, approximately 15 per cent for corn, and the remainder for oats, sweetclover, alfalfa, and other crops common to the region.

Yields of small grain in the more nearly level areas are about the same as those obtained on Crete silt loam. In the more eroded areas, however, yields are lower because the heavy claypanlike subsoil lies nearer the surface and the thinned topsoil is unable to store sufficient moisture for good yields. Corn, except in seasons of unusual precipitation, is poorly suited to the soil even in the more nearly level areas, because its moisture requirement during periods of prolonged drought exceeds the moisture-storing capacity of the 12-inch topsoil.

The uncultivable areas of Thayer silt loam are used for pasture, producing good growths of buffalo, grama, and bunch grasses which will support from 60 to 70 head of cattle on each quarter section during the summer grazing season.

Pawnee silt loam.—Pawnee silt loam is similar to Crete silt loam, except that it contains a noticeable amount of coarse sand and fine gravel throughout and usually occurs in more sloping and slightly more eroded topographic positions.

The soil is inextensive and of little agricultural importance in Thayer County. Most of it occurs in small isolated bodies on the valley slopes along Big Sandy and Dry Sandy Creeks. The largest area, including about 170 acres, is northwest of Alexandria.

Similar soil occurs extensively in Pawnee and Johnson Counties, Nebr., where it occupies the more nearly level or gently undulating uplands and is used in the production of small grain and corn. The relief of Pawnee silt loam in Thayer County, however, is not so favorable to crop production as that of Crete silt loam. Most of the soil is subject to slight erosion and, although suited to the same crops as the Crete soil, does not yield quite so well. About one-third of the land, including the more steeply sloping areas, remains in pasture.

Nuckolls silt loam.—Nuckolls silt loam is the most extensive soil of the Nuckolls series in Thayer County and has the greatest agricultural value. Its topsoil in the more nearly level situations is similar in most respects to the topsoil of the Crete and Hastings soils; that is, a dark-colored friable crumblike or granular silt loam 18 or 20 inches thick. The material is almost black in the upper part, owing to large accumulations of organic matter. In the lower part, however, the dark color is modified by a faint reddish tinge which does not occur in the Crete or Hastings soils. The upper subsoil layer is only 8 or 10 inches thick. It has about the same density and texture as the corresponding layer in Hastings silt loam, being only

moderately compact silty clay loam which affords easy penetration for moisture and plant roots. It is, however, much redder than the corresponding layer in Hastings silt loam, being uniformly dark reddish brown. The lower subsoil layer is friable pale reddish-brown silt loam containing considerable sand of the finer grades. Below a depth of about 4 feet most of the material is limy, the lime existing both in scattered hard white concretions and in powder-like form thoroughly mixed with the soil material. The organic matter, so abundant in the topsoil, gradually decreases with depth and is scarcely noticeable in the lower part of the subsoil. The soil throughout contains a few scattered gravel, but these exert no noticeable influence on its physical characteristics.

Nuckolls silt loam is an important soil in the southeastern part of the county. It occurs on valley slopes and over low divides between drainage ways wherever erosion has exposed a reddish slightly sandy loesslike material. This soil and its light-colored subsoil phase occur chiefly in Rose Creek Valley and along drainage ways leading to Little Blue River from the south, especially between Hebron and Gilead.

The greater part of Nuckolls silt loam is strongly rolling and is subject to more or less erosion. The dark-colored topsoil, except on the more level areas, is in no place more than 12 inches thick, and in places has been entirely removed, exposing the reddish-brown subsoil and giving the areas a spotted black and reddish-brown appearance.

Nuckolls silt loam is the soil affected least by injurious erosion, only about 20 per cent of it being unsuited to cultivation. The uncultivable areas of these soils produce a good growth of grama, bluestem, and other nutritious pasture grasses and are used chiefly for cattle grazing.

The more nearly level areas of this soil are well suited to all crops commonly grown on Hastings silt loam. They are especially adapted to corn and are largely used for this crop. Small grains are grown over a large part of the land on the more rolling areas. Sweetclover is grown to some extent in rotation with wheat, oats, and corn and is well suited and beneficial to the more sloping and eroded areas.

The continued use of Nuckolls silt loam for crop production depends on the control of destructive erosion. The soil where uneroded is as strong and productive as any upland soil in the county. As a whole, however, its productiveness and adaptability to crops have been greatly reduced by erosion.

Nuckolls silt loam, light-colored subsoil phase.—Nuckolls silt loam, light-colored subsoil phase, differs from typical Nuckolls silt loam chiefly in the absence of any noticeable compaction in the upper subsoil layer and in the higher lime content of its lower subsoil layer. The lime in the lower part of the subsoil occurs in finely divided form thoroughly mixed with the soil material, in filmlike coatings over large clods, and as numerous hard more or less egg-shaped concretions some of which are 2 inches in diameter and 6 or more inches in length. The greater part of this soil occupies steeply sloping surfaces. Erosion is very active, and the dark-colored surface soil is largely removed. On the steeper slopes a large part of the land has been gullied to such an extent that it is no longer culti-

vable. It is estimated that more than half the total area is unfit for cultivation. The less rolling areas support a good growth of native grasses and are used principally for grazing. The comparatively small areas of smoother surface are used principally for small grains which mature early and consequently do not require moisture in the late summer months as does corn. Average yields are much lower than on typical Nuckolls silt loam. Sweetclover is grown to some extent on the rolling areas.

Nuckolls loam.—Nuckolls loam in the more nearly level areas is similar to Nuckolls silt loam except that it contains a little more sand and gravel in all layers. The amount of coarser material in the surface soil is sufficient to give a loamy texture to that layer.

Erosion has been more rapid on this soil than on the silt loam, and the dark-colored surface soil has been removed more extensively. On the steeper slopes both surface soil and subsoil have been removed in places and about 30 per cent of the land has been so gullied as to be uncultivable. The value of a large proportion of this soil has been greatly reduced, owing to erosion.

The cultivable areas of Nuckolls loam are about as productive as areas of Nuckolls silt loam having similar topographic features. The same crops are grown in about the same proportion on the smoother areas of the two soils. The more rolling areas are used more extensively for small grains, chiefly wheat, than for corn. The larger acreage of small grains on this land is not owing to any special suitability for small-grain production, but because these crops are better suited to the unfavorable soil conditions than corn.

Lancaster fine sandy loam.—Lancaster fine sandy loam occupies only a small acreage in Thayer County. Most of it occurs in two narrow strips in the valley of one of the larger tributaries of Rose Creek, and a small area is in Spring Branch Valley north of Williams. The surface of the land is more or less sloping, and the soil in most places is subject to considerable erosion.

The outstanding characteristics of this soil are the sandy texture and the pronounced reddish tinge of the subsoil and substratum. It has developed from the lowest exposed bedrock in the region, a reddish-brown loosely indurated sandstone which is responsible for the coarse texture and reddish color of the lower soil layers.

The topsoil is loose fine sandy loam, in few places exceeding 6 or 8 inches in thickness. It ranges from grayish brown to very dark grayish brown, depending on the amount of organic matter retained. The material is not very coherent and in cultivated fields is subject to blowing in places, especially during dry seasons. Here and there in such fields the black organic matter has been almost entirely removed by wind or water, and the topsoil is incoherent grayish-brown fine sand. The subsoil is reddish-brown or yellowish-brown, with a reddish tinge, fine sand or fine sandy loam which rests on the underlying reddish-brown sandstone at a depth ranging from 24 to 36 inches beneath the surface of the ground.

The soil in most places is very droughty and of little agricultural value. Some of it is used for corn production, but the greater part remains in pasture. The native grasses are more luxuriant than on Sogn silt loam and the land has a little higher grazing value, especially during early summer. In the latter part of July, however, the grasses often wither and can not be depended on for late grazing.

Corn is the chief crop of the cultivated area, but on account of the droughty character of the soil the yields are low except in seasons of unusually heavy precipitation. Small-grain crops are not suited to the soil because of the danger of soil drifting and the consequent exposure of the shallow root systems.

Sogn silt loam.—Sogn silt loam occurs wherever Thayer silt loam has been so severely eroded that only a very thin soil has been left over the limestone bedrock. In most places the soil consists of very dark grayish-brown silt loam, ranging from 4 to 10 inches in thickness, which rests directly on the white limestone. Exposures of the bedrock are numerous throughout areas of this soil.

The soil occurs chiefly in narrow strips on the lower valley slopes of tributaries leading to Rose Creek in the southeastern part of the county. A few narrow strips occur in Little Blue River Valley north of Gilead.

The surface is everywhere too rough for farming operations, and all the soil is used for grazing land, but it is not of high value even for that purpose, as the grasses in most places are rather sparse owing to the nearness of the bedrock to the surface.

Scattered scrubby trees, including elm, ash, cottonwood, hackberry, oak, and cedar, grow on this soil and are used chiefly for firewood and posts. The limestone bedrock is used locally in the construction of farm buildings, for which purpose it serves fairly well. However it is too soft for use in large structures.

Shelby fine sandy loam.—Shelby fine sandy loam is the most extensive member of the Shelby series in Thayer County. The surface soil is very dark grayish-brown granular fine sandy loam, rich in organic matter and containing some gravel. The underlying layer is slightly lighter colored, a little more compact, and in most places is reddish fine sandy loam which gives way at a depth of about 24 inches to reddish-brown gravelly sandy loam containing only sufficient silt and clay to bind the sand particles loosely together.

On account of its small extent, generally unfavorable relief, and high gravel and sand content which allows rapid loss of moisture, this soil is of little agricultural value in Thayer County. It is used locally for corn, and a small acreage is in wheat. Yields of wheat and corn, however, are low and uncertain, even in the most favorable localities, on account of the droughtiness of the soil. Less than 15 per cent of the land is under cultivation. The uncultivated areas are used mainly for pasture. The grass cover will support from 50 to 70 head of cattle on each quarter section during the summer grazing season.

Shelby very fine sandy loam.—Shelby very fine sandy loam is similar to Shelby fine sandy loam except that the topsoil contains less fine sand and more very fine sand and silt. The finer texture of the material gives a more stable surface soil and a very slightly higher agricultural value. Corn is the principal crop. The soil is used in places for wheat production but yields are low. The surface is nearly everywhere rolling and over the greater part of the area is sharply rolling and in places badly eroded. It is estimated that only about 30 per cent of this soil is cultivated.

Shelby gravelly loamy sand.—Shelby gravelly loamy sand has a topsoil composed chiefly of sand and gravel with barely sufficient

organic matter to give it a loamy texture. The surface layer is considerably lighter in color and thinner than in the fine sandy loam and very fine sandy loam members, being grayish brown and in few places more than 8 inches in thickness. The subsoil layers are similar to those in the other Shelby soils. Not more than 5 per cent of the land is under cultivation. Corn, sweetclover, and wheat are grown, but yields are low. The uncultivated areas have a low value for grazing.

POORLY DRAINED UPLAND SOILS

The poorly drained upland soils cover a comparatively small area in Thayer County, occupying only 3.1 per cent of the land in the county. This group includes silt loams of the Butler and Scott series. These soils occur in shallow basinlike depressions, locally called buffalo wallows or lagoons, throughout the more nearly level parts of the well-drained group of soils. Although numerous, most of the depressions are small. A few of the larger areas are southeast of Bruning and Belvidere and northeast of Carleton.

The features common to the soils in the depressions are the result of poor drainage. Those soils subjected to the least excess of moisture have black granular topsoils, similar to the corresponding layers in the well-drained upland soils, except they are a trifle thinner and usually contain a little more clay. Those subjected to excessive moisture in larger amounts have decidedly thinner topsoils. Owing to excessive leaching, the topsoils in many of the more poorly drained soils are very light in color, especially in the lower part. The upper subsoil layers are extremely dense and claypanlike. The lower subsoil layers, however, are loose, light colored, and, except where moisture has been unusually abundant, very limy.

About 10 per cent of the area occupied by soils of the poorly drained upland group is periodically too wet for cultivation. In the cultivable areas, the topsoils are usually saturated with moisture in early spring, but as they are somewhat thinner than the topsoils in the claypan soils of the well-drained upland group, they have less water-storing capacity, and during the latter part of summer they often become extremely dry throughout, especially in seasons of low rainfall. Moisture conditions as far as corn is concerned are even less favorable than on the claypan soils of the well-drained group because the abundant moisture in early spring allows the corn plant to make an unusually heavy growth which renders it poorly suited to endure the dry conditions prevailing in the soil during late summer. Winter wheat is the chief crop grown on the cultivable parts of the poorly drained upland soils, and this crop occupies more than three-fourths of the farmed land. Wheat can be planted in late summer when the soil is sufficiently dry for plowing and seeding. It grows very rapidly during early spring and usually matures before the topsoil moisture is exhausted. Oats and sweetclover occupy most of the cultivable land not occupied by wheat. Oats do as well as wheat providing moisture conditions are favorable at the time of spring planting. As sweetclover is suited to both wet and dry soil conditions, it thrives on the poorly drained soils of the upland. Moreover, this crop is beneficial to the soils because its large vigorous roots penetrate the claypanlike subsoil and on decaying leave open-

ings which improve the natural drainage, aeration, and physical condition of this layer. Oats and sweetclover, however, are less profitable than wheat and are of minor importance. None of the areas are as productive year in and year out as the Hastings and Crete soils, and some of them are of value only for hay and pasture. The soils, however, seldom occupy more than a small part of the farm on which they occur and do not greatly influence the total crop yields or general agricultural practices.

Owing to the heavy claypanlike character of the upper subsoil layer, underdrainage is everywhere restricted in the poorly drained upland soils. In many of the depressions water accumulates after heavy rains and remains on the surface for several weeks or months. A few of the basins have natural drainage outlets and surplus moisture does not accumulate. Between these two extremes nearly all conditions of surface drainage exist. All the soils, however, are subjected to more or less excessive moisture during at least a part of each year, the amount depending largely on the depth of the basins below an overflow outlet and the catchment area from which they receive surface run-off.

Butler silt loam.—Butler silt loam is the most extensive of the upland soils occupying depressions in Thayer County. Its total area, however, is small in comparison with that of Crete silt loam, and it is not quite so productive or so well suited to crops in all years as that soil, chiefly on account of less favorable drainage. It is, however, much better drained as a whole than Scott silt loam and is more productive. Most of the areas lying in the lower depressions are artificially drained, and practically all the soil is under cultivation.

The topsoil is almost black silt loam, rich in organic matter. It is deeper than in the Scott soil, being 15 or 17 inches thick. The soil although occasionally inundated, except where artificially drained, has been subjected to less moisture than Scott silt loam, as is indicated by the crumblike or granular structure of the topsoil. The topsoil of Butler silt loam also shows less evidence of leaching than the corresponding layer in Scott silt loam, and the light-gray leached layer, which occurs in some places in the lower part of the Scott topsoil, is absent. The upper part of the subsoil is almost black dense clay and the lower part is light gray, limy, and friable.

The topsoil is slightly thinner than the topsoil of Crete silt loam, and although equally as granular, apparently has a higher clay content which tends to counteract the beneficial effects of granulation. The Butler soil can not be cultivated without injury under so wide a range of moisture conditions as the Crete soil. This is well demonstrated in fields including both soils. If such fields are cultivated as soon after rains as moisture conditions in the Crete silt loam become favorable, the associated Butler soil invariably puddles, bakes, and becomes cloddy, thereby losing an excessive amount of moisture through evaporation.

Successful crop production in dry years on this soil, as on Crete silt loam, depends largely on the moisture stored in the topsoil, and the soil is naturally better suited to shallow-rooted and early-maturing crops than to those which require moisture in large amounts throughout the summer. About 80 per cent of the soil

is used for wheat. Most of the remainder, except small areas which are in sweetclover or native grasses, is used for corn. In normal years crops yield as well as on Crete silt loam. In unusually wet or dry seasons, however, yields are more variable. In dry years the wheat yield is from 10 to 15 per cent and the corn yield from 20 to 30 per cent less than on the Crete soil. In wet seasons corn yields usually equal those on Crete silt loam, but wheat yields are somewhat lower because the slightly depressed relief favors the accumulation of a little too much moisture in the Butler soil, and the stalk has a tendency to make rank vegetative growth at the expense of the grain.

Scott silt loam.—Scott silt loam is the most poorly drained soil of the upland depressions. Most of it occupies the deeper basins or deeper parts of the basins, and the soil has apparently been subjected to excessive moisture in larger amounts and for longer periods than Butler silt loam. The topsoil is very shallow and consists of rather heavy silt loam, ranging from less than 6 to about 10 inches in thickness. It is somewhat variable in structure, but lacks the pulverulent granular structure of the corresponding layer in Crete silt loam or Butler silt loam. The upper half or three-quarters of the layer is almost black, owing to an abundance of well-decomposed organic matter. The lower part may or may not be dark, but is generally more leached and lighter in color than the overlying material. In places it is almost white.

The subsoil extends to a depth ranging from 5 to 6 feet. It is mottled steel-gray and bluish-gray heavy plastic clay which is very impervious to water. When dry the material is difficult to penetrate with a spade or auger. As far as can be determined by the usual field methods, the excessive moisture has removed all traces of lime from both surface soil and subsoil.

Scott silt loam is the most difficult to handle and the least productive of the upland soils. If plowed when wet, hard clods are formed and subsequent freezing and thawing or wetting and drying is required to restore favorable tilth. When dry the land is extremely difficult to plow. Practically all the soil is included in farm pastures. Many of the smaller bodies occur within cultivated fields but are seldom tilled on account of their poor drainage.

The native vegetation on the soil includes coarse marsh grasses, rushes, sedges, and other water-requiring or water-loving plants. Ironweed is so common on Scott silt loam in Thayer County that it may almost be considered a certain indicator of the soil.

Any attempt to use Scott silt loam for cultivated crops necessitates artificial drainage which is generally very difficult to establish because the surrounding land is higher in most places. Even when drainage is established the land remains comparatively unproductive because the topsoil is not thick enough to store sufficient moisture and the claypanlike subsoil releases moisture too slowly for grain and tame-hay crops, especially in dry seasons. The soil occurs in small patches and seldom occupies more than a small percentage of the farms on which it occurs. The increased returns obtained by artificial drainage are so slight that they do not warrant the expense involved in ditching and tiling such small areas. There is little advantage in using the soil for cultivated crops because a certain amount of pasture is required on all farms, and since Scott silt loam

in its natural condition serves almost as well for grazing land as for good farming land, its use for pasture is considered economical.

Associated with Scott silt loam in upland depressions are a few small areas in which the soil is transitional in drainage and character between Butler silt loam and Scott silt loam. The topsoil resembles that layer of Scott silt loam, except that it is 2 or 3 inches thicker and a little more granular. The upper subsoil layer is black clay somewhat resembling the corresponding layer of Butler silt loam, but it averages a little thicker and denser. The lower subsoil layer is light-gray limy friable silt. The total area of this soil is only 1,408 acres, and only about 100 acres are used for crops, chiefly wheat. The average yields are low. Had this soil been more extensive, it would have been shown on the soil map as Fillmore silt loam which is rather extensively developed in Clay and Fillmore Counties to the north.

ALLUVIAL SOILS

Alluvial soils occupy 14.9 per cent of the land in Thayer County. They occur as almost continuous strips, ranging in width from a few rods to more than a mile, either as terraces or first bottoms along all the larger drainage ways. The areas along Little Blue River, Big Sandy Creek, and Rose Creek are the widest. All the areas of alluvial soils are nearly level or very gently sloping and, except in local patches in the lower-lying parts of the first bottoms, are well drained.

About 85 per cent of the land occupied by the alluvial soils is under cultivation. Those parts not used for cultivated crops include a few poorly drained areas and narrow timbered strips adjacent to the stream channels in the first bottoms and small areas of extremely sandy and unstable soils on the terraces.

The alluvial soils naturally receive some water through run-off from the uplands and in places through seepage from streams. This, combined with moisture received through precipitation, makes them, with a few exceptions, the most productive corn and alfalfa soils in the county. Small grain also does unusually well, especially on the fine-textured second bottoms or terraces. On the first bottoms small-grain crops generally receive a little too much moisture and have a tendency to produce a rank vegetative growth at the expense of the grain.

The approximate proportion of the cultivable alluvial soils devoted to corn, wheat, alfalfa, and oats is 45, 35, 12, and 8 per cent, respectively, on the terraces, and 65, 10, 15, and 10 per cent, respectively, on the first bottoms. The proportional acreage devoted to alfalfa is much greater than on the uplands because stands of this crop are more easily obtained, yields are higher, and the crop remains profitable for a longer period. Decreased yields, resulting from a second or third cropping to alfalfa on account of depleted subsoil moisture, seldom occur on the alluvial soils because the alfalfa roots are able to reach either the underlying water table or a permanently moist substratum layer.

Conditions in the alluvial lands have been especially favorable for the accumulation of organic matter and nearly all the soils have deep dark topsoils. The only exceptions occupy less than 300 acres and include two extremely sandy and unstable soil areas in which the topsoils are light colored. The subsoils vary considerably, most

of them being fine textured, having high moisture-retaining powers, and being essentially similar to the more friable subsoils in the well-drained upland group. A few however, are coarse textured, being composed largely of sand and gravel, and they are not retentive of moisture. Those soils having sandy or gravelly subsoils are invariably characterized by coarse-textured topsoils.

Waukesha silt loam.—Waukesha silt loam, with a total area of a little more than 23 square miles, is the most extensive of the alluvial soils. It occurs as broad strips in the valleys of Spring Creek, Big Sandy Creek, Little Blue River, and in many of the smaller valleys throughout the eastern part of the county. The surface soil is very dark grayish-brown or almost black silt loam, from 16 to 20 inches thick. Some slight differences in texture occur, the soils ranging from silt loam to fine sandy loam, but these differences have not appreciably changed the agricultural value of the soil. The subsoil is grayish brown and moderately heavy. No lime occurs to a depth of many feet. The principal crops grown on this soil are corn, wheat, oats, and alfalfa, ranking in acreage in the order named. Yields of these crops are somewhat higher than on the best upland soils of the county. The average yield of corn over a period of years is about 40 bushels to the acre, of wheat 20 bushels, of oats 40 bushels, and of alfalfa 3 tons.

Waukesha very fine sandy loam.—Waukesha very fine sandy loam is very similar to Waukesha silt loam except that the surface soil contains a large proportion of very fine sand. The sand is never sufficient, however, to greatly affect the agricultural value of the land. The subsoil is very slightly lighter in texture, as a rule, than that of Waukesha silt loam. This soil is low in lime to a considerable depth. There is little difference in the agricultural practices and the yields obtained on the two soils. Wheat is slightly less productive on the very fine sandy loam and its acreage is relatively less than on the silt loam. This soil occurs principally along Spring Creek, Big Sandy Creek, Dry Sandy Creek, and Little Blue River, and in small areas along the smaller streams in the eastern part of the county.

Hall very fine sandy loam.—Hall very fine sandy loam covers a total area of more than 8 square miles. It occurs in small areas along the larger streams in close association with the Waukesha soils. The surface soil is very dark grayish-brown or almost black fine sandy loam. The upper subsoil layer is heavier than the surface soil and somewhat compact. The lower subsoil layer is mellow light grayish-brown silty material, the color being due in part to a large proportion of lime. There is little difference in agricultural value between this soil and the Waukesha soils. Corn, wheat, oats, and alfalfa are the principal crops. Yields compare favorably with those on the Waukesha soils and other good soils of the county.

Judson very fine sandy loam.—Judson very fine sandy loam occurs on terraces and gentle colluvial slopes. It is developed over fine-textured materials washed down from the rich black soils of the uplands. The soil is very dark grayish-brown or almost black very fine sandy loam containing much silty material. The dark-colored surface layer is thicker than in the upland soils, commonly ranging in thickness from 16 to 20 inches, and in places where colluvial deposition has been rapid it may be 36 or more inches in thickness.

The subsoil is brown silty loam or very fine sandy loam, differing little in texture from the surface soil.

Where the surface is smooth and other conditions are favorable, this soil is not surpassed in productivity by any other soil of the county. It is especially suited to corn production, and average yields of 40 bushels to the acre are obtained. Small grains and alfalfa also make good yields.

Judson fine sandy loam.—Judson fine sandy loam contains more fine sand and less very fine sand at all depths than Judson very fine sandy loam, but in other respects there is little difference between the two soils. The coarser texture of the fine sandy loam slightly lowers its agricultural value. Corn is the principal crop with yields about equal to those on the very fine sandy loam. Small grains make lower yields in dry years but the difference is not great. This soil is of comparatively little importance in the agriculture of the county as it covers less than 2 square miles.

Wabash silt loam.—Wabash silt loam covers a total area of more than 9 square miles, lying mainly in the valleys of Rose Creek and its tributaries. The surface soil is dark grayish-brown or almost black silt loam from 16 to 20 inches thick. The soil is mellow and easily tilled. No lime can be detected to a depth of more than 3 feet. The subsoil is silty clay loam or silty clay and ranges in color from brown to dark grayish brown or almost black. Where drainage is adequate this soil is very productive, comparing favorably in this respect with the Waukesha and Judson soils. The greater part of the soil is cultivated, principally to corn, wheat, oats, and alfalfa, ranking in acreage in the order named.

Wabash very fine sandy loam.—Wabash very fine sandy loam differs from the silt loam of the series principally in its lower silt content and its larger proportion of very fine sand. It differs little in agricultural value. The sandier texture is slightly less favorable to small grains. This soil is of little agricultural importance as it covers only 0.2 per cent of the county.

Lamoure silt loam.—Lamoure silt loam is a first-bottom soil very similar in appearance to Wabash silt loam. It differs from that soil, however, in having more or less lime in the lower part of the subsoil. The surface soil is almost black heavy silt loam which, under proper moisture conditions, is mellow and easily cultivated. The upper subsoil layer, which begins at a depth ranging from 15 to 20 inches, is dark grayish-brown or mottled gray and brown silty clay loam or silty clay. At a depth between 2 and 3 feet the subsoil in most places becomes calcareous and lime is abundant. This soil is flooded occasionally, but drainage is fairly good and water does not stand over the surface more than a few days at a time. There is no better cornland in the county than this soil and Wabash silt loam, and alfalfa does well on the better-drained areas. Lamoure silt loam is rather poorly suited to small grain, especially in seasons of high precipitation when the water table rises on these bottom lands causing wheat and oats to produce a rank vegetative growth at the expense of the grain. Corn on this soil yields about 50 bushels, wheat from 12 to 18 bushels, oats from 20 to 30 bushels, and alfalfa 3½ tons to the acre.

O'Neill very fine sandy loam.—O'Neill very fine sandy loam varies greatly in different areas. The surface soil is dark grayish-brown

fine sandy loam, ranging in depth from 8 to 14 inches. The subsoil is composed of gray sand and gravel. In most places the coarse-textured porous material directly underlies the dark-colored surface soil. This soil is excessively leached, and the lime has been removed.

The productivity of this soil depends on the thickness of the finer-textured surface soil, which is everywhere more or less droughty. Corn and small grains make only average yields as the roots of these crops in dry seasons seldom reach the water-bearing sands that underlie the terraces. Alfalfa does well providing the precipitation is sufficient to sustain the plants until the roots can reach the underlying water. A prolonged spell of dry weather during the first year after planting usually results in a very poor stand of alfalfa, and because of this, alfalfa is grown on a very small part of the land. That part not used for cereal crops and alfalfa remains in wild grass and is used mainly for pasture.

O'Neill sandy loam.—O'Neill sandy loam differs from O'Neill very fine sandy loam principally in the coarser texture of the surface soil, the sand content being composed more largely of the medium and coarse grades. The subsoil material is made up of loose porous sand and gravel. This soil has a total area of 2 square miles and occurs mainly on the higher gravelly terraces along the larger streams. Owing to the coarser texture of the surface layer, this soil is slightly less favorable to crops than O'Neill very fine sandy loam, and owing to its porous subsoil it is equally droughty. As a whole this soil may be rated slightly lower in agricultural value than O'Neill very fine sandy loam.

O'Neill sand, light-colored phase.—O'Neill sand, light-colored phase, consists of dark grayish-brown sand underlain by grayish-brown sand. The content of organic matter is low and as a result the surface soil is not so dark as that of the other O'Neill soils. There is not sufficient organic matter and other fine material in the surface soil to prevent the soil drifting in dry windy weather. This soil is less productive than the heavier O'Neill soils. It is extremely droughty and crops can not be grown in ordinary seasons. It is used mainly for pasture and hay land, but its value even for these purposes is low. This soil is so inextensive that it has no great influence on the agriculture of the county as a whole.

Cass fine sandy loam.—Cass fine sandy loam is the most extensive of the first-bottom soils. The surface soil is very dark grayish-brown or almost black fine sandy loam, from 6 to 10 inches thick. The upper subsoil layer is brown or grayish-brown fine sandy loam containing more silt, as a rule, than the surface soil. Lime may or may not be present in this layer. Below a depth ranging from 15 to 24 inches is a bed of loose porous sand and gravel.

The underlying water table throughout the cultivated areas of Cass very fine sandy loam is seldom more than 10 feet below the surface of the ground, and the subsoil layers are almost continually wet. Moisture conditions, therefore, are very favorable for the production of corn and alfalfa, and these crops yield about as well as on the finer-textured Wabash and Lamoure soils.

This soil varies in productiveness in different places according to the thickness of the surface soil and differences in topographic position. The better part of the soil is used for the same crops as the Waukesha soils. The land is less productive, however, on ac-

count of the sandiness and porosity of the subsoil. About 60 per cent of the land is used for corn and 30 per cent for alfalfa; the remainder, including areas in which the water table is too near the surface of the ground for cultivated crops, is used for pasture, hay, or woodland.

Cass silt loam.—Cass silt loam is similar in most respects to Cass fine sandy loam. It contains, however, a larger proportion of silt in the surface soil and in the upper 2 feet of the subsoil. This siltier texture gives the soil a slightly higher agricultural value. Corn does well and makes higher average yields than on Cass fine sandy loam. The soil is of little importance in the agriculture of the county as it has a total area of only 832 acres.

Sarpy sand.—Sarpy sand consists of light-colored loose sand underlain by loose sand and gravel. It occurs on the first bottoms of the large streams of the county and is subject to frequent overflow. This soil is used chiefly for wild hay and pasture land. Some areas support rather dense growths of cottonwood, elm, and willow trees and are included in wood lots.

AGRICULTURAL METHODS AND PRACTICES

The agricultural methods and practices in Thayer County are similar to those throughout south-central Nebraska.

The corn crop matures in September or early in October, depending on the season. The greater part is husked from the standing stalks, after which cattle and horses are pastured in the fields during the winter. Some farmers annually fence off a few acres of unhusked corn for fattening hogs and cattle, thereby saving part of the expense of husking.

Small grain is usually sowed with a press drill on well-prepared corn or stubble ground. The wheat crop usually matures in July. It is cut with a binder or header, depending on the length of the stems and either shocked or stacked for threshing. Oats, rye, and barley are planted and harvested in the same manner as wheat, except that the seed is usually drilled in as early in spring as the condition of the soil allows.

The sandy areas of the county are seldom plowed more often than once in three or four years, as annual disking maintains the land in good tilth.

Seed selection is not generally practiced. Some farmers purchase seed from corn grown outside the county. This practice, however, is not usually rewarded with the highest yields because such seed, although belonging to one or another of the corn varieties known to be well suited to the county may have become adapted to different climatic and soil conditions than those under which it is to be used. Recommendations for selecting seed corn by the State experiment station at Lincoln, Nebr., include the selection of seed from grain known to have been grown in the locality and to have become adapted to local climatic and soil conditions. The usual method of obtaining small-grain seed is to clean a sufficient amount of the previous crop for the next season's planting. Practically all the alfalfa seed used in the county is shipped in.

Alfalfa is usually sown either in April or August. A stand of alfalfa is ordinarily allowed to remain from six to eight years, or

as long as it remains profitable. It is rarely frozen out. The crop is usually cut three times during the summer, and occasionally a fourth cutting is obtained. It is common custom to stack the hay in the field and haul it to the feed lots as needed. Alfalfa is fed to cattle and hogs but seldom to work horses because of its laxative properties. Many farmers allow hogs to run in the alfalfa fields during the summer. Cattle, however, are seldom allowed to graze for long periods on green alfalfa on account of the danger of bloating.

No systematic crop rotation is practiced in the county, although some progressive farmers have evolved more or less indefinite systems and change their crops with reasonable regularity. On tenant farms much of the land is planted to the same crop for several consecutive years. This results in a noticeable decrease in yields. Oats are seldom grown more than 1 year in the same field, the crop being used mainly as a step in the rotation between corn and some other small grain or alfalfa. Many farmers seed stubble ground to alfalfa, and the stand is allowed to remain 6 or 7 years before the land is broken and planted to grain crops. A crop rotation which seems to have merit is corn, 2 years; oats, rye, or barley, 1 year; wheat, 2 years; and sweetclover, 2 or 3 years.

Practically no commercial fertilizer is used. The 1920 census reports commercial fertilizer applied on only three farms in 1919. Many farmers use barnyard manure, but the supply is seldom adequate for best results, and ordinarily little care is given to preserve manure. Most of it is piled out of doors without protection, and by the time it is hauled to the fields much of its fertilizing value has been lost through leaching. The more progressive farmers haul the manure directly from the barn or feed lots to the fields, applying it mainly to corn and wheat land. On most tenant farms the land nearest the barnyards receives most of the manure. The growing and plowing under of legumes or other green crops as soil-improvement crops is seldom practiced.

SOILS AND THEIR INTERPRETATION

Thayer County is in the prairie region of the United States. All the soils except those on the steeper hillsides or on recently exposed or recently deposited light-colored parent materials have accumulated enough organic matter from decayed grass roots to make their surface layers decidedly dark. These layers are also prevailingly granular or crumblike in structure.

The county is in a region of moderate rainfall, the mean annual precipitation being 27.62 inches. The moisture entering the soil has not been sufficient to leach the readily soluble salts from the entire soil except in the more sandy areas and in some areas which are favorably situated to receive run-off from higher lands. In most soils of the county, the soluble salts, chiefly lime carbonate, have been leached from the upper part of the soil and have accumulated in the lower part, producing a layer of higher lime content than occurs in any other part of the soil or in the parent soil material. This layer is commonly known as the lime zone.

In addition to having dark-colored granular topsoils and a lime zone in their subsoils, most of the soils of the county have developed

layers, or horizons, approximately parallel to the surface of the ground, occurring in a definite sequence from top to bottom and differing from one another in one or more important features, such as color, texture, structure, chemical composition, and compaction. These layers are the result of soil-forming processes. As a rule, the layers are best developed and most numerous in those soils which have been least affected by erosion and have lain for the longest periods of time in their present positions. Even in these localities, however, the layers are not equally well developed or equally numerous in all the soils. Their character and number in any particular soil depend to a large extent on the moisture conditions under which the soil has developed and the character of the material from which it has weathered.

Throughout the more nearly level or gently rolling parts of the uplands and on the terraces is a group of well-drained soils which have lain in their present positions for long periods; they have developed from parent materials easily altered by weathering, and a negligible part of the area occupied by them has been subjected to excessive erosion. The soils of this group have dark-colored topsoils consisting of three well-defined layers. The upper one is a very thin, loose, structureless mulch, seldom exceeding an inch in thickness. It is dustlike when dry. The second layer is laminated, the soil particles being grouped into thin, horizontal, disklike plates which overlap one another. The laminated material is from 2 to 5 inches thick, and the laminae are very fragile. The lower topsoil layer is decidedly granular. It is from 12 to 18 inches thick and extends to an average depth of 22 inches. In this layer the soil particles are grouped in small rounded or subangular aggregates ranging from one-sixteenth to slightly more than one-fourth inch in diameter. The larger aggregates are most abundant in the lower part of the layer.

The three topsoil layers are friable and in most places are similar in texture, being composed largely of silt, very fine sand, and organic matter. The distribution and stage of decomposition of the organic constituent is not uniform and the intensity of the dark color varies slightly in the different layers. The structureless mulchlike covering is lightest in color, being dark grayish brown or grayish brown, as its organic constituents are not all thoroughly decomposed. The laminated layer is the darkest, being almost black, and the color remains constant when the soil material is pulverized, indicating that the organic matter is thoroughly mixed with the mineral soil particles. In the granular layer the organic matter is not sufficiently abundant to thoroughly permeate the soil material, as in the overlying layer, but it is deposited as a film or coating on the surfaces of the granules. The film is thickest in the upper part of the layer, making a natural exposure of that part as dark and apparently as rich in organic matter as the overlying layer. The granular material, however, when crushed becomes lighter in color than similarly treated material from the laminated layer, indicating a lower organic-matter content per unit of soil volume. The organic film decreases in thickness with depth, and the lower part of the granular layer is dark grayish brown, or when crushed is grayish brown.

The fourth or upper subsoil layer is the one of maximum compaction. It is about 12 inches thick and extends to an average depth

of about 34 inches. The layer is not equally dense in all soils of the group, the degree of compaction varying with the surface features. It is naturally thickest and most compact in those areas where surface drainage has been rather slow. In some soils it attains claypan characteristics; in others it may be only moderately compact, but it is always more dense than any other layer of the soil. The material is grayish brown or dark grayish brown in most soils of the group; in a few, however, it has a pronounced reddish tinge. It varies considerably in structure. Where extremely dense and claypanlike it is in many places practically structureless, but where only moderately compact it can usually be broken into more or less cubical or prismatic-shaped structural units few of which exceed three-fourths inch in their longer dimension. The organic matter, as in the granular horizon, is largely only a film, or coating, on the surface of the structure particles. This film is somewhat thinner than in the overlying layer as evidenced by the lighter color of the horizon.

A fifth layer, transitional in character between the zone of maximum compaction and the lime zone, is present in some of the soils of the group. It is columnar but otherwise structureless. The material is grayish-brown somewhat compact silty clay loam in the upper part, but becomes rapidly lighter colored and looser with depth, being light grayish-brown flourlike silt in the lower part. It usually merges with the lime zone at a depth ranging from 4 to 5 feet. The transitional layer, although very pronounced in most of the friable soils of the group, is very poorly developed and in many places absent in those soils having claypanlike zones of maximum compaction. The claypan when present usually rests directly on the material of the lime zone and may even contain some lime in its lower part.

The lime zone is the next layer in most of the soils of the group. When present it is composed largely of silt, is usually loose and floury, more or less columnar, and very light grayish brown, light yellowish brown, or almost white. However, it may have a reddish cast in those soils which have weathered from limestone or from reddish-colored loess, and its upper part may be somewhat compact in soils having an unusually dense claypan layer. The zone contains an abundance of lime occurring chiefly as hard or soft concretions, spots, splotches, fine winding threads, thin fillings in numerous seams and cracks, and other concentrated forms. The maximum lime concentration occurs only in the upper part of the zone and seldom exceeds 8 or 12 inches in thickness. The lime segregations gradually diminish with depth, and the carbonates in the lower part of the zone occur chiefly in finely divided form thoroughly mixed with the silt. In most areas all traces of lime disappear below a depth of 60 or 70 inches, except in soils overlying limestone formations.

The soils of the well-drained group contain worm casts and elongated, twisted, rodlike forms of various lengths in all layers beneath the laminated one, especially in the granular layer. The worm casts are more or less spherical and about one-sixteenth inch in diameter. They may be grouped in rounded clusters containing from 10 to 25 individuals or may occur as fillings in old root or insect cavities. The rodlike forms, often called borings, are also fillings in root or

insect cavities and may at one time have consisted partly of worm casts, but if so, the casts in most places have become obscured and the material comprising them has been blended into a uniform mass. The borings are usually lighter or darker than the general color of the layer in which they occur, depending on whether the material composing them was derived from underlying or overlying layers.

The upland soils of the group described are members of the Hastings, Crete, Pawnee, Nuckolls, and Thayer series, and the terrace soils belong to the Hall and Waukesha series. The Hastings and Crete soils have weathered from a light-gray or yellowish-gray limy and silty formation known by Nebraska geologists as Peorian loess, and the Hall and Waukesha soils have as parent material this loess reworked by streams. The upper subsoil layers of all these soils are similar in color, that is, brown or grayish brown. In the Waukesha soils these layers consist of friable silt loam which is only slightly more compact than the topsoil. In the Hastings soils this zone consists largely of silty clay and is moderately compact, whereas in the Crete soils it is extremely dense clay. The Hall soils may be regarded as terrace equivalents of the Hastings soils, although locally their zones of maximum compaction are a little denser than in the Hastings soils. The lower subsoil layers, except in the Waukesha soils which have no zone of lime accumulation in the solum, are characterized by well-developed lime zones.

The Pawnee soils have dense claypanlike upper subsoil layers and pronounced zones of lime accumulation in their lower subsoil layers. They are essentially similar to the Crete soils, but have weathered from glacial drift and contain a few of the more resistant pebbles throughout.

The Thayer soils have developed from limestone formations, and the claypanlike part of their subsoils and the lower part of their topsoils have a pronounced reddish cast.

The Nuckolls soils have weathered from parent material known in the Nebraska surveys as the Loveland phase of the loess. This material is pale-red friable silt containing some sand, chiefly of the finer grades. It underlies the light-gray practically sand-free Peorian loess of the uplands and is thought to be older and more oxidized. The material has been exposed over rather large areas in Thayer County and where thoroughly weathered has developed into soils resembling those of the Hastings series except in their slightly coarser texture and decidedly more reddish cast in the subsoils.

In some places the Pawnee, Thayer, and Nuckolls soils have been subjected to rather severe erosion which has thinned or entirely removed their topsoils, slightly altered the character of their upper subsoil layers, and prevented the development of a lime zone in their lower subsoil layers. With the exception of such areas, which are very inextensive, the profiles of the Pawnee, Thayer, and Nuckolls soils are about as described in preceding paragraphs.

A few soils in Thayer County have developed on materials recently removed from the uplands by surface wash or colluvial action and deposited near the base of the more gradual slopes, on narrow valley floors, or on gently sloping terraces. The deposits are very dark, having been derived chiefly from dark-colored upland soils. They are of such recent age that sufficient time has not elapsed for the development of definite zones or layers. The soils derived from

these deposits are classed in the Judson series. They are very dark grayish brown or black, have no definite structure, and are uniform in color and texture beyond a depth ranging from 4 to 5 feet. They have been leached of their carbonates.

Associated with the Hall and Waukesha soils, but occupying the more sandy parts of the terraces, are soils of the O'Neill series. These soils have developed from water-laid sands and gravel and are extremely resistant to weathering. Most of them have accumulated considerable organic matter and have deep dark topsoils. A few, however, have weathered from parent materials of such recent or unstable origin that the soils have accumulated very little organic material and have rather light-colored topsoils.

The O'Neill soils have no surface drainage but their openness and porosity have allowed excessive downward leaching and the removal of all soluble carbonates. Definite zones or layers are not developed, and the material beneath the topsoil is incoherent gray sand or a mixture of sand and gravel.

In the sharply rolling and hilly parts of the county is a group of soils which have been subjected to more or less constant erosion. This group includes the Shelby, Sogn, and Lancaster soils and an eroded phase of Hastings silt loam. In these soils the rapid surface run-off has removed the weathered soil material almost as fast as it has formed, and the unweathered geologic formations from which the soils are forming are near the surface of the ground. The topsoils have accumulated more or less organic matter and are very dark, but they are everywhere much thinner than the topsoils of the Hastings, Crete, and Thayer soils. Zones of compaction and lime accumulation are absent or but poorly developed. In fact all characteristics resulting from prolonged undisturbed weathering are feebly expressed or absent, and the soils do not differ greatly from the parent materials.

The Shelby soils, in the more protected situations, have very friable topsoils from 5 to 12 inches thick, which vary in texture and color ranging from fine sandy loams to gravelly loamy sands and from grayish brown to very dark grayish brown. The coarser-textured topsoils are structureless throughout, but the finer-textured ones, in many places, are faintly granular, especially in their lower parts.

The upper subsoil layer extends to an average depth of about 20 inches. It is slightly more compact, a little more granular, and considerably lighter in color than the topsoil. In most places it has a faint reddish tinge and consists of sandy or gravelly clay loam.

The lower subsoil layer continues to a depth of about 30 inches below the surface of the ground. The material composing this layer is a mixture of slightly weathered reddish-brown, or brown with a pronounced reddish tinge, somewhat loamy sand and gravel. The loaminess is owing to a considerable content of clay which loosely binds the coarser particles together.

Beneath the lower subsoil layer is a grayish-brown, gray, or reddish-brown incoherent mixture of coarse sand and gravel, the gravel ranging from very small to 1½ inches in diameter.

On the steeper hillsides the dark-colored layer in the Shelby soils seldom exceeds 4 inches in thickness, and it is underlain by a more

or less incoherent mixture of sand and gravel which is reddish brown in the upper part of the layer and gray in the lower part. The Shelby soils do not contain sufficient lime to react with dilute hydrochloric acid. The gravelly material from which they have weathered has been carried to its present position by streams. Part of it probably came from the tertiary formations to the west. A part, however, is undoubtedly drift material washed in from glaciated areas.

The Sogn soils have developed in places where erosion has exposed limestone or shale beds to weathering. They occur only on slopes along the more deeply intrenched valleys, chiefly in the southeastern and east-central parts of the county. Drainage is unusually excessive, and erosion is severe. The topsoils are dark grayish-brown or very dark grayish-brown faintly granular silt loams, fairly well supplied with organic matter and seldom more than 5 or 6 inches thick. Underlying the topsoil is friable light-gray silt or silty clay containing numerous limestone or shale fragments in various stages of disintegration. The silt content decreases and the stone fragments become more numerous, larger, and better preserved with depth, until the soil material rests on the unweathered parent formation about 2 feet below the surface of the ground. On the steeper slopes all soil material has been removed and white limerock or light-colored shale is exposed.

The Lancaster soils have weathered from reddish-brown loosely indurated sandstone known geologically as Dakota sandstone. The topsoils seldom exceed 4 inches in thickness. They are similar in color and structure to the topsoils of the Sogn soils, but they contain more sand. The subsoils are composed of pale reddish-brown sand intermixed with sufficient silt and clay to produce a loamy texture. In most places the parent sandstone occurs within a depth ranging from 18 to 24 inches. The Lancaster soils occur only on the lower valley slopes along Rose Creek in the southeastern corner of the county where erosion has removed the overlying formations and exposed the Dakota sandstone to weathering.

The eroded phase of Hastings silt loam occupies narrow strips on the steeper valley slopes throughout the loess-covered parts of the county. Its topsoil averages only about half as thick as that of the Hastings soils developed on the more nearly level upland areas. On most slopes the topsoil has been entirely removed in places by erosion, giving the surface a spotted dark and light appearance. The rapid surface run-off has prevented much water from entering the ground, and in most places the surface soil, to a depth of only 8 or 10 inches, is leached of its carbonates. The remainder of the topsoil consists of gray friable loess which has been little modified by weathering. The loesslike material is very calcareous, but has developed no definite zones or layers of true soil character.

In Nuckolls County to the west, eroded soils in corresponding positions were correlated with Holdrege silt loam, eroded phase. On account of the gradual disappearance of the Holdrege characteristics. it was thought best to class these soils in the Hastings series in Thayer County.

A group of soils including soils of the Butler, Scott, Lamoure, Wabash, Cass, and Sarpy series has developed under poor drainage. The Butler and Scott soils occupy level or depressed areas through-

out the smoother loessial uplands, and the remaining soils of the group occur in flood plains along streams.

The stage of development attained by the Butler and Scott soils is not clearly understood. These soils, although subjected to excessive moisture, show one or more characteristics common to the smooth well-drained soils of the uplands and terraces. In fact, some of the characteristics, especially in the subsoil, are even more pronounced than in the Hastings and Crete soils, and they become increasingly pronounced as drainage decreases. Other characteristics, however, occurring chiefly in the topsoils, become less pronounced under decreasing drainage. Possibly all soils of the Butler and Scott series were formerly well-drained, normally developed soils which have been altered by poor drainage. On the other hand, it is possible that they have been subjected to poor drainage throughout all stages of their formation. Regardless of the stages through which they have passed in their development, they differ in one or more respects from the smooth well-drained soils of the uplands and terraces.

The Butler soils, although poorly drained, have been less affected by excessive moisture than the Scott soils. They usually occupy almost level areas but may occur in slightly depressed situations. They are transitional in drainage and development between the Crete and Scott soils. The topsoils, which are very friable and almost black, average about 15 inches in thickness. They include three horizons, a structureless surface mulch from one-half to 2 inches thick, a laminated layer from 2 to 4 inches thick, and a granular horizon which occupies the remainder of the topsoil. The granules in the lower horizon are irregular in shape and vary somewhat in size, but seldom exceed one-fourth inch in diameter. Most of these granules are sprinkled with almost white flourlike silt which becomes more concentrated with depth and in some places considerably lightens the naturally dark color in the lower 2 or 3 inches of the granular material.

The subsoil includes two horizons. The upper one is a true claypan and is more compact than any other layer in the profile. It is about 20 inches thick and consists of very dark grayish-brown or black comparatively impervious clay. The material is structureless and breaks into irregularly shaped angular lumps of various sizes. It has a dull appearance even when moist.

The lower subsoil layer lies below an average depth of 40 inches. It is a layer of carbonate accumulation and consists of loose gray or light-gray silt or silty clay loam containing scattered rust-brown stains and an abundance of lime. The carbonates are most concentrated in the topmost 4 to 10 inches of the layer, where they occur chiefly as soft and hard concretions. In the remainder of the layer most of the lime is disseminated. The carbonates become less abundant with depth, disappearing entirely below a depth of about 7 feet, or the lower limits of the layer.

Beneath the lower subsoil layer is loess, a yellowish-gray, floury, siltlike deposit containing scattered rust-brown stains and spots. The material is not calcareous to a depth below 10 feet.

The Butler soils differ from soils of the Crete series chiefly in the darker color of their claypan layers. They differ from the Scott soils in the better development of their granular layers, the darker

color of their claypans, and the total absence of large hard black concretionary forms in the claypan.

Included with the Butler soils, on account of their small extent, are a few small areas of soils mapped in other counties as Fillmore soils. These soils occupy shallow upland depressions and have been subjected during formation to a little more moisture than the Butler soils. Their topsoils average a little thinner and usually contain more gray material in the lower part than do the Butler soils, and the claypanlike layer in the subsoils contains scattered hard round black ferruginous concretions from one-eighth to one-fourth inch in diameter. Otherwise, the included soils are very similar to the Butler soils.

The Scott soils are the most poorly drained of the upland soils. They occur only in the deeper basinlike depressions and have been subjected to excessive moisture in larger amounts than have the Butler soils. Downward percolation of water, therefore, has been more continuous and its results more pronounced. The topsoils are friable or only slightly compact, and they range from less than 2 inches to about 12 inches in thickness. They are variable in structure, but most of them are more or less laminated, and few of them contain a pronounced granular layer. The upper half or three-quarters of the topsoil is almost black, but most of the material contains considerable light-gray or almost white floury silt which lightens the basic shade in many places. The lower part of the topsoil may or may not be dark, ranging from almost black to white, the color depending on the concentration of white floury silt. In many places where the material is unusually light in color, it contains numerous black hard round concretionary forms from one-sixteenth to slightly more than one-fourth inch in diameter.

The subsoil, a true claypan, consisting of heavy structureless, plastic clay, extends to a depth ranging from 5 to 6 feet. Excessive moisture has given the material a lead-gray or dark bluish-gray color, in many places mottled with rust-brown stains, streaks, and splotches. The claypan contains scattered black concretionary forms similar to those occurring in many places in the lower part of the topsoil. Below the subsoil is the parent material of light yellowish-gray loose floury silt similar to that beneath the Hastings, Crete, and Butler soils. It is not calcareous to depths below 8 or 10 feet.

The Scott soils differ from the Butler soils in the lighter and more mottled color of the claypan and in the absence of a zone of lime accumulation in the solum.

All the characteristics of the Scott soils are apparently the result of excessive moisture conditions. In many places water stands on these soils from a few weeks to several months, and the vegetation in many places consists of a rank growth of rushes and reeds. The subsoils are almost continually saturated and have been thoroughly leached of their carbonates.

The remaining soils of the group under discussion, those of the Lamoure, Wabash, Cass, and Sarpy series, occupy flood-plain positions along streams. The moist conditions prevailing in the flood plains have especially favored vegetative growth and decay, and all the soils, except those developed from the most recent alluvial deposits, have dark-colored topsoils. The parent materials, however, are so recently deposited that they have not developed into soils

having true soil zones or layers. In most places oxidation and aeration have been greatly retarded by excessive moisture, and in many places the topsoils rest directly on unweathered or only slightly changed parent alluvial sediments. The character of the sediments, therefore, is the controlling factor in determining the character of the flood-plain soils.

Those soils which have weathered from fine-textured sediments, largely silts and clays, are classed in the Lamoure and Wabash series. The topsoils are friable, almost black, and from 12 to 14 inches thick. Owing to a rather high clay content, the subsoils are moderately compact. The subsoils of the Wabash soils are similar to, or only slightly lighter in color than the topsoils and are very low in lime. In the Lamoure soils the subsoils are light grayish brown, dark grayish brown, or mottled gray and white. They contain an abundance of lime in both concretionary and disseminated forms.

The coarser-textured flood-plain sediments of Thayer County consist largely of sands and gravels which have weathered into the Cass and Sarpy soils. The Cass soils have accumulated considerable organic matter in their surface layers and have a very dark grayish-brown or almost black topsoils from 6 to 10 inches deep. The Sarpy soils have weathered from more recently deposited materials and are poorly supplied with organic matter, their topsoils being very light in color. The subsoils of both the Cass and Sarpy soils are composed largely of loose gray sand and gravel, the gravel, in most places, becoming more abundant with depth. The soils may or may not contain lime, but if lime is present, the carbonates are in finely divided form and are evenly distributed throughout the soil.

SUMMARY

Thayer County is in southeastern Nebraska. It is almost square and comprises an area of 575 square miles, or 368,000 acres. The county is a part of a flat to steeply rolling and, in places, hilly plain which slopes gradually toward the southeast. The flatter areas occupy the broader upland divides and the terraces and flood plains along streams. The average elevation of the county is about 1,540 feet above sea level.

The first settlement in the area now included in Thayer County was made in 1858. Early settlers came mostly from States farther east. They were of many nationalities, people of German extraction being especially numerous. According to the 1920 census report the population of the county, all classed as rural, was 13,976 in that year. Hebron is the county seat and largest town.

Thayer County has good transportation facilities. It is crossed by railroads in several directions, and all points in the county are within 8½ miles of a railroad station. Two graveled highways cross the county, and well-kept earth roads reach all farming communities. Kansas City and St. Joseph are the chief markets for grain and livestock.

The climate is moderate and well suited to agriculture. The mean annual temperature at Hebron is 51.4° F., and the mean annual precipitation is 27.62 inches. The average frost-free season is 161 days.

The agriculture of the county consists of diversified farming, including grain and hay production, and the raising of livestock. The

chief crops are corn, wheat, oats, alfalfa, wild hay, and coarse forage, ranking in acreage in the order named. Nearly one-third of the county and more than one-half of the cultivated acreage is devoted to corn. Small orchards and gardens are maintained on practically every farm. Dairying and the raising of cattle, hogs, horses, and poultry, constitute the major livestock industries.

The soils of the county occupy two topographic positions, the uplands and the alluvial lands. The upland soils cover about 85 per cent of the county and include three major groups, namely, well-drained, poorly drained, and excessively drained soils.

Soils of the well-drained group occur in the more nearly level parts of the uplands and are the most extensive. They include the Crete and Hastings silt loams, both of which have deep dark-colored topsoils. The subsoils in the Crete soil are claypanlike and in the Hastings soil are loose and friable. Shallow-rooted and early maturing crops, such as wheat and oats, do better than corn on the Crete soil, because such crops require moisture in smaller amounts and for shorter periods of time, as they usually mature before the water stored in the topsoil during the winter is exhausted. Wheat is the leading crop on Crete silt loam. Hastings silt loam, having a friable subsoil, is equally well suited to both corn and wheat. Corn, however, is more profitable than wheat and occupies the largest acreage.

The poorly drained upland soils occupy numerous small basinlike depressions throughout soils of the well-drained group. They include the Butler and Scott silt loams, all of which have claypanlike layers in their subsoils.

The excessively drained upland soils include an eroded phase of Hastings silt loam and the Thayer, Pawnee, Nuckolls, Shelby, Sogn, and Lancaster soils. These soils occur in strips of various widths on the larger and many of the smaller drainage ways, chiefly in the eastern half of the county. The soils as a group have been subjected to considerable erosion and, except on the more gradual slopes, conditions have been unfavorable for deep soil weathering and the accumulation of large amounts of organic matter. The topsoils, therefore, average thinner than those in soils of the well-drained group.

About 70 per cent of the area occupied by the excessively drained upland soils is under cultivation, and the rest is used chiefly for pasture. Corn is the leading crop on most of the cultivated land, the wheat acreage exceeding that of corn only on the steeper and more eroded slopes.

The alluvial soils occupy about 15 per cent of Thayer County. They occur as almost continuous strips either on terraces or first bottoms along all the larger drainage ways. They include the Waukesha, Hall, Judson, O'Neill, Wabash, Lamoure, Cass, and Sarpy soils. The first four occupy terrace positions, and the others occur in the flood plains.

About 85 per cent of the area occupied by the alluvial soils is under cultivation. The finer-textured soils of this group are the most productive corn and alfalfa soils in the county. Those soils occupying terraces are well suited to wheat.

[PUBLIC RESOLUTION—No. 9]

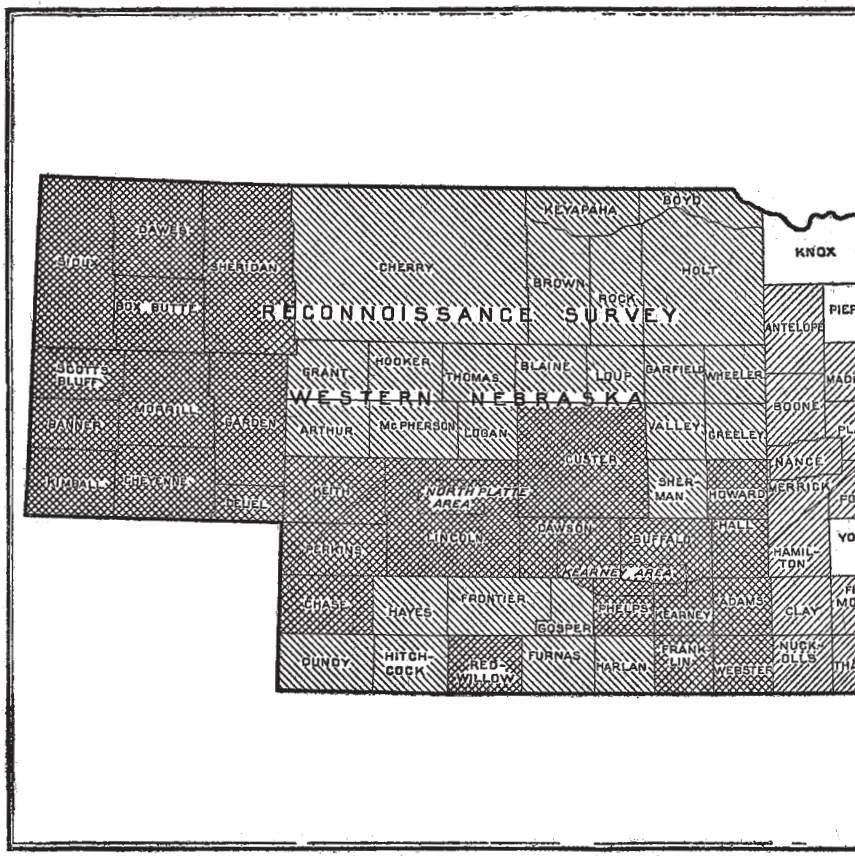
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Nebraska, shown by shading

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
A. G. McCALL, CHIEF, SOIL INVESTIGATIONS
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

THAYER COUNTY
NEBRASKA

UNIVERSITY OF NEBRASKA
STATE SOIL SURVEY DEPARTMENT OF THE
CONSERVATION AND SURVEY DIVISION
G. E. CONDRA, DEAN AND DIRECTOR

LEGEND

- Butler silt loam — Bu
- O'Neill sand, Light-colored phase — Od
- Cass fine sandy loam — Cf
- O'Neill sandy loam — Os
- Cass silt loam — Cl
- O'Neill very fine sandy loam — Ov
- Crete silt loam — Cr
- Pawnee silt loam — Ps
- Hall very fine sandy loam — Hv
- Sarpy sand — Sd
- Hastings silt loam — Hs
- Scott silt loam — S
- Eroded phase — Hs
- Shelby gravelly loamy sand — Sy
- Judson fine sandy loam — Jf
- Shelby fine sandy loam — Sr
- Judson very fine sandy loam — Jv
- Shelby very fine sandy loam — Sv
- Lamoure silt loam — Ls
- Sogn silt loam — Ss
- Lancaster fine sandy loam — Ll
- Thayer silt loam — Ts
- Nuckolls loam — Nl
- Wabash very fine sandy loam — Wv
- Nuckolls silt loam — Ns
- Wabash silt loam — Wl
- Light-colored subsoil phase — Ns
- Waukesha very fine sandy loam — Wf
- Waukesha silt loam — Ws

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S. township and section lines

RELIEF
(Printed in brown or black)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low-water line, Sandbar

DRAINAGE
(Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Thomas D. Rice, Inspector, District 3.
Soils surveyed by E. A. Nieschmidt, in charge, R. H. Lovald and R. L. Gemmell, Nebraska Soil Survey and R. C. Roberts, U. S. Department of Agriculture.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

Litho. A. Hoen & Co., Inc.

Field Operations
Bureau of Chemistry and Soils
1927